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VIEWS, NEWS AND INTERVIEWS.

The truly gifted engineer always makes one part of his work fit into another, and no energy is ever wasted, says an exchange. A wealthy engineer who had set up a very fine place in the country, where he had carried out many pet constructive projects, was visited there by an old friend.

The visitor had so much difficulty in pushing open his front gate that he spoke about it to the proprietor.

"You ought to fix that gate," said the guest. "A man who has everything 'just so' should not have a gate that is hard to open."

"Ha!" exclaimed the engineer, "you don't understand my economy. That gate communicates with the waterworks of the house, and every person who comes through it pumps up four gallons of water."

Mr. Brayton Ives, of New York city, chairman of the Executive Committee of the Westinghouse Electric and Manufacturing Company, last week bought for $1,000 a fine park horse called "X Ray."

Walter K. Freeman, the electrical engineer who has achieved notoriety in many ways, has had another unusual experience. He is on trial in New York city for seduction, and makes his residence in the Tombs. One day last week, while taking walking exercise in one of the jail corridors, Freeman's pocket was picked of his watch. It was found in the possession of one Smith, awaiting trial for burglary. Freeman's experience brings to mind the old story of the convict in Sing Sing who couldn't find his cap. He went to Principal Keeper Connaughton and exclaimed, "Mr. Connaughton, there are thieves in this prison!"

This story of the late Sir Andrew Clark, the English physician, is told by a writer in *Cassell's Magazine*. "Two years ago the son of a wealthy nobleman lay in San Francisco suffering from typhoid fever. His friends longed to obtain the advice of the great English physician, but Sir Andrew could not be brought over in time. Nevertheless, his aid was obtained. The famous doctor went to the London end of the cable; the other end was laid into the sick room in California. Thus a consultation was held under the sea between the English medical authority and his American colleagues, the very beat of the sufferer's pulse being registered from time to time, thousands of miles away. The lad recovered."

Russia is to have an electrical branch of her army, under a lieutenant-general, two major-generals and five officers of lower grade, who will also have a military electrical school under their charge. Russian military officers have always been adept in the use of electricity.

"We don't want any X-ray jokes," said the editor of an exchange.

"Very well," said the humorist; "we will return it to the package and produce the joke about the X-ray joke. Ah, that is played out, too? Then permit me to show you my newest joke about the joke about the X-ray joke, and if that will not do I still have in reserve——."

He got the quarter.

A New Scale Wire Bridge.

The Buffalo Instrument Company, of Buffalo, N. Y., are the manufacturers of the portable scale wire bridge illustrated herewith. A general view of the instrument, which is claimed to be an entirely new departure, is given in Fig. 1. The diagram of connections is shown in Fig. 2. The bridge is contained in a mahogany case separate from the batteries. There is but one plug to the bridge, which reduces the liability of variable resistance through bad contact of plugs to a minimum.

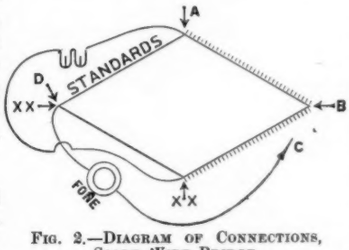


FIG. 2.—DIAGRAM OF CONNECTIONS, SCALE WIRE BRIDGE.

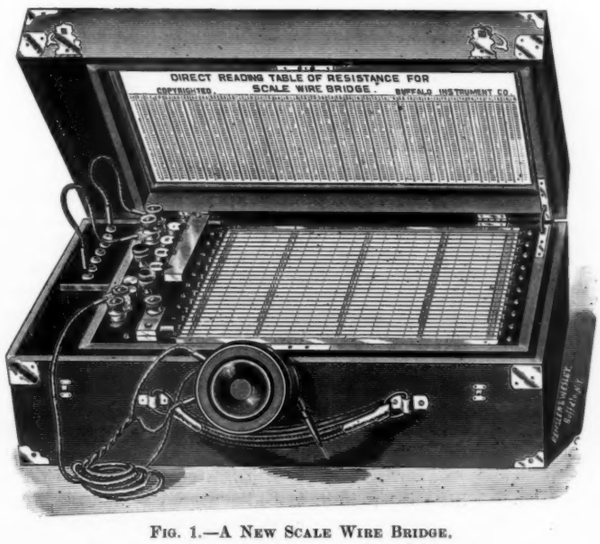


FIG. 1.—A NEW SCALE WIRE BRIDGE.

The variable resistance of the bridge is composed of a continuous scale wire, 500 inches in length, stretched around suitable insulated pins at the end of a table. Under the table is a chart divided into 1,000 half inches; each half inch is divided into 10 degrees, which virtually divides the scalewireinto 10,000 separate units or degrees. The chart facilitates reading the scale in making measurements.

The standards of resistance or multipliers of the bridge are 1 ohm, 10 ohms, 1,000 ohms and 10,000 ohms, respectively. The standards are calibrated to embrace one-half of the scale wire, 5,000 units or degrees of the scale (from A to B, Fig. 2), while the other side of the coils is connected to multiplier post D. The standard would be from letter B to A to D. The unknown is across the remaining leg of the diagram (from D to XX).

One side of the receiver or galvanometer is connected to D, the other side being at C, which is a finder or contact to be used in tracing the neutral point over the scale, between XX to B and A. The battery connects between points A and XX.

To find the neutral point, the finder or pointer C is drawn over the manifolds of the "scale wires." It is readily determined on which wire the neutral point lies, as the receiver indicates a sharp, loud sound, except when at the neutral point or close to it, when it becomes weaker and finally is silent at the neutral point. Readings taken with this style of receiver have proved to be fully as sensitive as with the ordinary galvanometer, and in many instances much closer results have been obtained with it. The chart under the scale wire gives the degree of the scale.

This style of instrument is so simple that no adjustment of the instrument is necessary before it is ready for use.

The Central Union Telephone Company will shortly issue $1,600,000 bonds. The company has a large floating indebtedness, and one-half of the bond issue will be used in payment to the American Bell Telephone Company in discharge of the latter company's account against the Central Union. The other $800,000 of the bonds will be offered to stockholders at 97½ on the basis of $100 in bonds for every four shares of stock.

ELECTRICITY AND WATER POWER.

BY MARK A. REPLOGLE.

(Continued from page 190.)

MAGNETISM.

Magnetism is always found where there is any electrical phenomena, and on account of this has caused much confusion in the minds of students. In one sense it might be considered the only avenue through which electricity has any power value to man. Magnetism is not electricity, but it is incident to it, and always bears a certain relation to it. If an electric current is in motion, lines of magnetic force are passing around the current (in reality, running at right angles to the current). If the current of electricity should change to the opposite direction, the lines of magnetic force immediately reverse, keeping at right angles to the current.

Lines of magnetic force are nothing more than rows of atoms polarized; that is, arranged in regular order. It will be remembered that each atom of matter is supposed to have a positive and a negative pole, and when the atoms of any portion of material are polarized it becomes a magnet. So magnetism is nothing more than a condition of the material surrounding an electric current, and it is not electricity. We only know that this is a fact; but none can tell whether it is out of respect to the passing current or whether some unknown law compels lines of magnetism to run around the passing current.

The work done by electricity is done by the magnetism surrounding the passing current and not by the electricity itself. If lines of force or magnetism are caused to run around a wire which is a part of a complete circuit, the electricity in the wire will move in one direction. If the lines of force were to move in the opposite direction, the electricity in the wire would also move in the opposite direction. This principle is the foundation of all dynamos.

Let this be understood: A *wire* or any *conductor*, having a *current* of electricity passing through it, has *lines* of *magnetic force* passing *one way* around it, and the *number* is in the *direct* ratio to the *quantity* of current passing through the wire. This magnetic effect is strongest close to the wire, and decreases inversely as the square of the distance.

A permanent magnet has lines of magnetic force continually passing through it. It is possible that, if all were known pertaining to it, a continuous current of electricity might be somewhere found that makes or keeps it a magnet, or else the magnet may be keeping up a current somewhere.

ARC ELECTRIC LIGHTING.

Having dwelt at some length on the principles of the flow of currents, phenomena attending such flow become easy to understand, and we will begin with lighting and display the principles of all the well-known phenomena.

If electricity were forced through material that offers a high resistance to it, the mechanical power required to force it through such resistance would be converted into molecular motion or heat. If the area of resistance is small, the heat is intense, and becomes more intense as the quantity of current increases. Air offers a very high resistance to currents, hence becomes white-hot when electricity passes through it. (A current passing through air is called an arc.) If the ends of the wire were used to cause the arc, they would melt from the excessive heat and could not be regulated properly, hence carbon pencils are used.

The pencils do not melt, but shell off in a kind of carbon vapor, and the friction caused by the current passing through the air heats it and the carbon points to a white heat, emitting light. Arc lights are made from both continuous and alternating currents. The former flow in one direction only, and the latter are currents that are reversed many hundred times in a minute. (Since electricity has no inertia, it can be reversed very quickly, and a reversing current is called an alternating current.)

The small machinery in an arc lamp is for regulating the distance between the carbon points as they wear off. A two-thousand (2,000) candle-power arc lamp requires a trifle over one horse-power of mechanical energy to run it. Arc lights usually are connected in series; that is, follow each other in the same wire, and the pressure must be increased as each new lamp is put into the circuit.

INCANDESCENT ELECTRIC LIGHTING.

The incandescent light is caused by making a small portion of the wire so small that it becomes heated by the current. Nearly all of the materials in nature will oxidize or burn when white-hot, in ordinary atmosphere, but the commercial incandescent lamp has its contracted or small conductor in a glass globe, from which the oxygen has been removed, and the filament, as it is called, is nothing more than a carbonized thread of some strong fiber, such as bamboo or linen.

Since the oxygen is gone from the globe, the filament can not burn and remains intact until weakened by scaling and crystallization. Both continuous and alternating currents are used for incandescent lighting, and the lamps are usually in multiple; that is, each is fed from the same feed wire, and each receives the full pressure of the dynamo or transformer. In some cases these lamps are used in arc circuits, but there must be enough of them in multiple to allow the whole current to pass without destroying the filaments by over-heating. From eight (8) to ten (10) sixteen-candle-power lamps can be had from one mechanical horse-power of energy. Some manufacturers claim more.

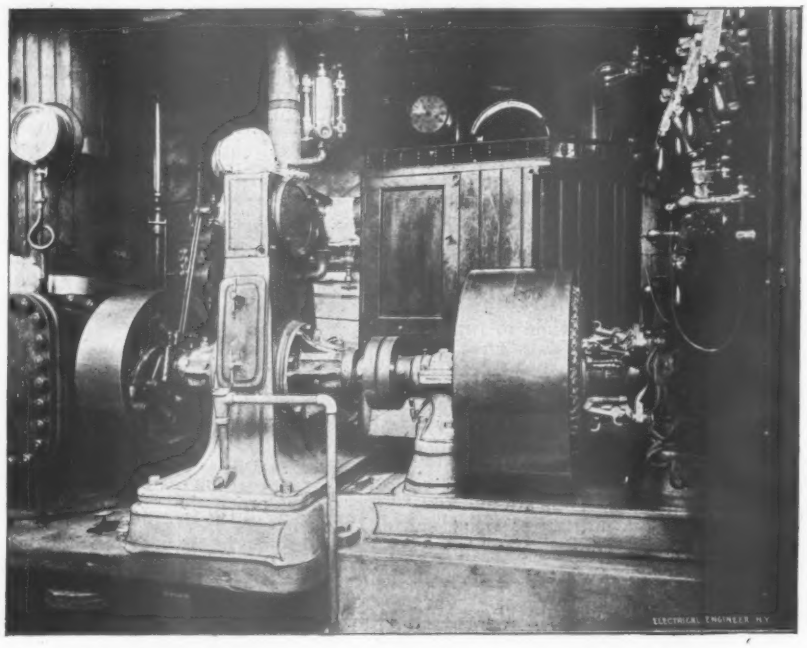


FIG. 1.—DIEHL DYNAMO DIRECT CONNECTED TO CASE ENGINE ON BOARD STEAM YACHT "REVERIE."

TRANSFORMERS OR CONVERTERS.

The electrical engineer, while scheming to transmit energy as cheaply as possible, must keep in mind the safety of the people who use it. It is a fact that the higher the pressure used to convey energy through a wire, the more can be carried on a given sized wire, but it is also a fact that the higher the pressure, the more dangerous does the wire become. So, by the use of the alternating current and transformer, high pressure and safety are both possible in the same installation. The high-pressure current is brought to a transformer outside of a building, and, after passing around the primary coils, returns to the dynamo.

Inside the primary coil is a secondary coil of larger wire, and both coils are inclosed in laminated soft iron cases. A new current is generated in the secondary coil of lower and safe pressure. This supplies the lamps in the building. (The new current is caused by induction, and is also an alternating current.)

Transformers can be constructed to step up to higher pressure, as well as down to lower. There is no gain or loss of energy save that due to friction, and if the pressure is stepped down, the quantity increases; if stepped up, the quantity diminishes, leaving the same amount of energy.

LUMINOUS OR SPRAY LIGHTING.

These phenomena are caused by exceeding high pressure and small quantities of electricity. They may be seen to a small extent by presenting a metallic point to a heavily loaded belt driving some machine. It can be seen best after dark. In such a case it is an intermittent current. Nikola Tesla is astonishing the world by this kind of phenomena from high-potential, alternating currents, and all eyes are turned towards him for facts in this line.

ELECTRIC POWER.

It has, no doubt, been noticed that lighting by electricity is a result of impeding the *electric current* by resistance; but power is the result of impeding the *magnetism around the current*. (This, in turn, impedes the current.) Work or power is acquired from the current, only by the use of the electro-magnet.

An electro-magnet is simply a concentration of the magnetism of a current through a long wire. If one inch of a conducting wire with a given current throws off a certain number of lines of magnetic force, 100 inches will throw off 100 times as many. So the 100 inches may be wound on a piece of iron called a core, and the full amount of magnetism will be concentrated in the ends of the core. If the iron is soft it ceases to be a magnet as soon as the current stops, and becomes a magnet as soon as the current passes again.

Here is the foundation of all our telegraph systems. The operator with his key starts and stops a current through the distant magnet. It in turn attracts a small piece of iron with a "click," and when the current is stopped by breaking the circuit a spring pulls the piece of iron away with a "clack." Combinations of clicks and clacks are letters and words.

The force with which an electro-magnet (properly constructed) attracts soft iron has led many searching minds to an idea of transferring power in a manner similar to the telegraph; that is, by wire. This idea has been experimented upon during the past few years to such an extent that it has been proved beyond doubt that energy or power can be transmitted great distances by the use of electric currents and with less loss than by any other means. Let it be understood, however, that there is no power in electricity except that put into it. In other words, the wire circuit is dead until we put the elec-

tricity it contains in motion by some external power or force. This can only be done by or through the means of magnetism, when our energy is applied in the form of power.

The machine that is constructed for the purpose of mechanically wrapping magnetism about or around the conducting wire is called a *dynamo*

FIG. 2.—NEW KNIGHT ARC LAMP.

by the electrician, and in doing so it consumes power in the same ratio that the current is allowed to flow through the wire, plus the friction or loss in heat. The battery puts the electricity in a wire circuit in motion by means of chemical action. One of the results of chemical action is electrical pressure, and if a wire is connected to a part of a battery that is under electrical pressure, and be continued even for a great distance, any point in this wire will be found to be under electrical pressure. If this wire is returned to the battery and connected to the part of it that is negative, or has a tendency to an electrical vacuum, then a current will flow as long as the chemical action continues in the battery.

The electric current generated by the dynamo is in all respects like the current generated by a battery; that is, a continuous dynamic current is identical with a battery current. The distant telegraphic instrument then by the proper remodeling becomes a machine that will take power from a passing current, and the part that only vibrated in telegraphy is placed on axles, and revolves when a current is passing through it. The instrument in this shape is called a *motor* by the electrician.

(To be continued.)

Desires Light on X Rays—Will Some Manufacturer Kindly Answer?

TO THE EDITOR OF ELECTRICAL REVIEW:

I am desirous of obtaining a little information regarding the X rays and do not know where to apply for it except to you, as I understand that your publication is at the head of everything in the electrical line. What I wish to know is how large a spark an induction coil is obliged to give in order to successfully work a Crookes tube in experimenting with the X rays; also, if the Crookes tubes are furnished in various sizes, and how small an induction coil and Crookes tube can be used that will demonstrate that the X rays exist.

G. E. S.

Towanda, Pa., April 16.

THE DIEHL MANUFACTURING COMPANY.

IMPROVED LINE OF MANUFACTURE BY THIS PROGRESSIVE COMPANY.

Coincident with the incorporation of the Diehl Manufacturing Company, of Elizabethport, N. J., and New York, and the addition of the word "Manufacturing" to the name, a new line of handsome Knight arc lamps, in a variety of styles, and the improved Diehl dynamos and motors will be placed on the market. At the present time the company's facilities at Elizabethport are taxed to the utmost for the production of Diehl electric fans, which have been long and so favorably known that it is said more than 11,000 of the suspended fans alone are in use.

FIG. 3.—NEW DIEHL CEILING FAN, VENETIAN DESIGN.

Of these fans the company this year is making new and beautiful designs in venetian, polished brass and nickel and variously ornamented styles, the important feature being, moreover, that a material decrease in the amount of power required has been made. The self-oiling motors in these fans are directly coupled to the fan shafts and operate on any direct-current circuit or work successfully in series on arc and street railway circuits.

The illustration, Fig. 1, is a reproduction from a photograph of a Diehl dynamo directly connected to a Case engine. This installation is on board the steam yacht "Reverie," owned by the president of the Singer Manufacturing Company.

These machines have the armature encircling and revolving around the field magnets, which results in high efficiency, great durability and slow speed, avoiding the method of countershafting and the loss of power it incurs. This slower speed, being due to the large diameter of the armature, is obtained without increase of weight and gives a starting torque proportionately great, at the same time increasing the efficiency by a diminution of friction of the bearings and the brushes. The motors are fitted with self-aligning and self-oiling bearings and approved brush-holders, thereby requiring a minimum of attention.

FIG. 4.—DIEHL BALANCE WHEEL MOTOR APPLIED TO SEWING MACHINE.

The illustration, Fig. 2, of the new Knight arc lamp hardly does justice to the elaborate line which the Diehl company are preparing, and for the outdoor lamp the company has perfected a design which will be water-proof without the use of a hood. The important feature which will recommend the Knight lamp is that the striking magnet is composed of a few turns of heavy wire placed in the main circuit, and, when the current is on, this magnet is energized and pulls down the core of the shunt armature, holding the core in this position until it is weakened by the lengthening arc, then the core of the shunt magnet is released and it goes up to the feeding point. The armature is then practically out-field of the striking magnet and the arc depends entirely on the shunt magnets for regulation. This avoids the defect usual in the shunt lamp of not striking a proper arc when current is turned on. The adjustable chuck carbon-holders take in any size of carbon from one-fourth of an inch to five-eighths of an inch in diameter. The clutch wheel is used, requiring no dashpot nor main magnets. The clutch is applied to the periphery of the wheel; therefore the rod is less liable to stick when dirty than in a lamp with clutch working directly on the rod.

Since the incorporation of the company these officers have been elected: E. H. Bennett, Jr., president; Philip Diehl, vice-president; H. S. Miller, secretary, and J. A. Reid, treasurer. John C. Knight, prominently known in connection with the arc lamp industry, will superintend the lamp making. The New York office will be at 561 Broadway, under the management of C. A. Bramhall.

M. T. Lindenburg will be in charge of the Boston branch, at 128 Essex street.

President Bennett informed a representative of the ELECTRICAL REVIEW that the company were now increasing their facilities by the installation of many thousand dollars worth of new machinery, and it is fair to presume that the Diehl Manufacturing Company will, in the near future, be in the front rank as a manufacturing company.

The illustration, Fig. 4, shows the balance-wheel motor, as applied to the shaft of sewing machines. The motor is self-contained and the field magnets are attached to the shaft of the machine for connection with the current. The armature carrier acts as a balance wheel and is secured to the shaft by the clamp-stock motion. The speed is manipulated by a small brake and rheostat operated by treadle.

Safety Insulated Wire and Cable Company.

The Safety Insulated Wire and Cable Company, of New York city, last week closed a contract amounting to about $125,000, to furnish all the underground cables required by the Boston, Mass., Electric Light Company during the current year. This is a renewal of a similar contract made in 1895, which was obtained on the strength of the showing made by Safety cables in 1894.

A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS.

READ BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, NEW YORK, MARCH 25, 1896, BY WILLIAM L. PUFFER.

(Concluded from page 198.)

Early in November last the subject was again taken up, with the very efficient aid of Mr. R. R. Lawrence, a post-graduate student in electrical engineering at the Massachusetts Institute of Technology, and rapidly developed with such beautiful results that it was decided to exhibit publicly before the Society of Arts, which was done some little while after, at the regular meeting of January 2, 1896.

We first attempted to take a set of instantaneous photographs of the arc at different periods of an alternation, and by the use of a pneumatic shutter, and a progressive motion of the lens, obtained some very sharply defined pictures. After many trials, this was given up, because of the practical impossibility of timing the exposures with respect to the alternations, and we decided to use a disk with half as many slots as there were pole-pieces on the dynamo, and to drive it by the shaft of the machine itself.

The dynamo available was one giving a three-phase, 500-volt current with a frequency of about 60 cycles. Two wires only were used to give us the current required.

A somewhat long, light shaft, carrying at one end the disk, and at the other a positive mechanical clutch, was mounted in line with the armature shaft. As the clutch could only be thrown in when the two shafts were nearly equal in speed, a small motor was placed so as to bring the disk up to speed when the clutch was thrown in and the motor belt removed.

The disk was held in place by a frictional clamp disk on the shaft. A graduation and reference mark served to measure angular change of disk on shaft, and therefore of slots with reference to the pole-pieces or alternation of the current.

The arc to be tested was put in a boxing to keep away air from the currents close behind the disk, and a camera with a roll-holder in front of the disk. With this arrangement the arc as seen was perfectly steady at any part of the wave that corresponded to the position of the disk on the shaft, and, as the process of stopping, setting, and starting the disk was very rapid, the roll-holder being in meantime turned, many pictures could be taken in a very few minutes.

Generally, it was not necessary to take more than 12 exposures in order to get a series showing clearly the changes in light intensities during a single phase.

We found that it was about as instructive to watch the appearance of the arc on the ground glass of the camera, and far more beautiful. In this way we examined both the effect produced in the arc by change in the voltage of the circuit, the current being kept constant by alteration of the resistance.

For example, with 500 volts, and a large non-inductive resistance in series with the arc, it was plainly evident that the current wave was approximately sinusoidal, as the time of extinction of the current, as indicated by the blue band of the arc proper, was very short, and the rise and fall of the current gradual and with no irregularities. This is to be expected, as the back electro-motive force of the arc is small compared to the voltage of the generator, and the circuit as a whole is non-inductive.

The opposite condition was realized by using a lower electro-motive force and regulating by a reactive coil. The time of no current was longer, and the current appeared to jump to its maximum in an exceedingly small angular time. In this case the arc was not steady, showing clearly to the eye that the succeeding waves of current were not alike either in form or current value, and also that the angle of lag was constantly changing. This fact has always prevented an accurate plotting of wave forms by the instantaneous contact method, and although known to exist, was never before actually seen.

A very pretty double arc was arranged by using three carbons and wiring two circuits, each with current regulators, in such a way that the arc was the common junction, and one carbon was of one polarity, while the other two were of opposite polarity. With wire resistances in each side, there was nothing peculiar to be noted other than the effects of the junction of two currents, but when the resistance in one circuit was gradually cut out, and equivalent inductance cut in, there was at once visible evidence of the lag of the current, together with the change of shape of the wave and the unsteadiness before noted. Owing to the long time of no current in the inductive side, there were times when, even with considerable lag, there were actually no visible traces of current between either points. This effect was dependent on adjustment of current strength and inductance as well as voltage. The sequence of currents and polarity in this arc was most beautifully brought out when the disk was disengaged from the shaft, and driven by the little motor at a rate very slightly less than the dynamo.

We found that work in the immediate vicinity of the dynamo was not very desirable, owing to air currents and excessive vibration, so we arranged a combination of motors that will produce at any distance from the dynamo all the desired results.

A very nicely balanced brass disk with four radial slots in it was attached to the armature shaft of a Holtzer-Cabot synchronous induction motor of eight poles. The pulley of this motor could be driven by a light belt from a self-starting induction motor of the same make, which is, however, not quite synchronous under load. By trial the two pulleys are wound with rubber tape until their ratio is such that the brass disk will be uniformly driven at a speed a trifle above synchronism, and the arc light can be seen through the slots to pass through the alternation at a desirable rate.

By a single movement of a switch the non-synchronous motor is cut out, and the synchronous cut into circuit when the armature drops into step with the dynamo, and the arc is instantly seen as fixed; the belt is thrown off or left on, as desired. These armatures may be on the same shaft, if necessary. The synchronous motor does not stand on its base, but rests on the turned outside of its bearings in pillow blocks, which are attached to a suitable base frame.

Concentric with the shaft and firmly attached to the motor is a brass gear, six inches in diameter, and on it a graduated circle. On a lever pivoted so as to be thrown to or from the motor gear is a small spur gear with a milled head for turning.

Turning this head will evidently cause the motor to slowly rotate about its axle, and as the armature must be in step with the dynamo, and, as the turning of the motor changes the position of a given pole-piece relatively to the arc light, it follows that any part of the alternation of current in the arc may be seen on the screen, and as the motor has eight poles, a quarter turn or 90 degrees on the graduated circle corresponds to a complete cycle in the arc.

The picture of the arc can then be photographed, measured, or in any way studied at leisure in any phase relation, as, for example, when the top carbon is positive, or when there is no arc at all and only dull red carbon points visible.

In this way we have seen single arcs of high and low electro-motive force, long and short double arcs, arcs with much inductance in circuit, Jablochkoff candles, arc between a ring and a point within, the spinning arc between the ends of a carbon cylinder and a concentric carbon within, with a magnetizing coil around the inner carbon and the like.

One of the most beautiful arcs investigated by us visually and photographically was a rotary arc made by the use of three carbons in the same plane, at angles of 120 degrees apart and wired up as the junction point of an external Y load on a 500-volt, 60 cycle, three-phase generator. Non-inductive resistance was used in the circuit, and the current used in one leg of the Y was 10 or 15 amperes.

Twelve photographs were taken at equal intervals of 30 degrees in an alternation of the current in one wire. Fig. 1 shows very clearly the relation of the current waves from the different carbon points, and the curved, fan-shaped figure indicates the position and direction of the bluish arc at the corresponding angle. The base of the fan rests on a positive carbon, which has a white-hot crater and all the appearance of the positive carbon of a direct-current arc, while the tip of the fan rests on the white spot at the end of a negative carbon.

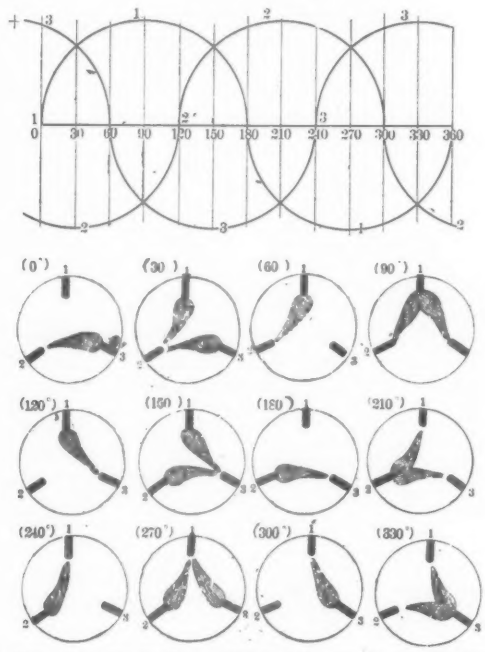
It will be seen at 0 degrees, for example, that there is no current on carbon 1 and that 2 is negative and 3 positive, the blue, fan-like arc curving from 3 to 2; 30 degrees later, 2 is still negative and 3 positive, but that an equal arc is now playing from 1 to 2. At 60 degrees 2 is still negative, 1 positive, but there is no current on 3. At 90 degrees the appearance is somewhat like 30 degrees, except that the signs are changed, and the point with the double current is necessarily much whiter, it being now positive. And so on through the changes of the complete wave.

This three-phase arc, when seen while the disk is running non-synchronously, is the most beautiful of any studied, and may be seen according to the different length of arc and the divergence of the disk from exact synchronism, either as a band of blue light, which seems to be progressively traveling over the three sides of a triangular path, or as a rapidly spinning star of blue light, being in fact a rotary arc.

The three phase arc is less noisy than the single-phase, and its light is steadier and has less variation in its total intensity, owing to the fact that the current never stops, and there is always a positive carbon. Three-cored carbons, placed parallel side by side, with slight magnetizing coils to keep the arc at the ends of the carbon, will give a very satisfactory light in the direction away from the tips, and may be used when it is desirable to throw all the light in one direction.

Four carbons, at 90 degrees apart, each with a suitable resistance in series with it, and connected to quarter-phase tap wires on a Gramme ring or other generator giving quarter-phase circuits, will also produce a rotary field arc of great beauty and interest.

Study of these arcs is still going on at the Institute of Technology under my immediate charge, which will, I hope, produce results sufficiently interesting to justify a second paper at some later date.



A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS.

McClure's Magazine for May will have an article by the eminent surgeon, Dr. W. W. Keen, indicating the uses already possible, as well as those likely to become possible soon, of the Roentgen rays in the study and cure of human deformities, injuries, and diseases. The article will be fully illustrated from photographs taken by the new process.

ROENTGEN RAY DIFFUSION AND OPALESCENCE*—A NOVEL PHENOMENON.

BY ELIHU THOMSON.

So far as the writer is aware, the phenomena presently to be described have not hitherto been alluded to by writers or experimenters on Roentgen rays. They are the phenomena of diffusion of Roentgen rays by certain classes of substances in such a way that such substances must be regarded as opalescent or to act like opal glass with respect to ordinary light, or like milky liquids exhibiting diffusion of light from the interior and exterior of the mass.

Some substances are found to behave with Roentgen rays like compacted snow or translucent ice in diffusing light.

Let a large metal screen, such as a brass or iron plate, of one-sixteenth to one-eighth inch in thickness, be suspended in a vertical place about a foot or more from a Crookes tube kept in action and emitting Roentgen rays toward the plate. On the side of the plate opposite to that next the Crookes tube there will, of course, be a shadow space free from Roentgen rays. While this statement is true in the abstract, it may easily happen that an exploration with a fluorescent screen tube or fluoroscope back of the metal plate will show that the rays are not absent, but appear to come around the edge of the plate. This phenomenon has been alluded to by Mr. Edison, and used in support of his supposition that the rays are high-pitch sound.

But on close examination it will be found that the rays back of the metal shield are, mainly, at least, due to diffusion from surrounding objects—the walls or floor of the room, or objects receiving the rays and scattering them.

Further examination will disclose the fact that bodies differ greatly in their diffusive power, and that substances, such as paraffine, wood, paper, pine, rubber, cloth of cotton, or wool, the hand of the experimenter, etc., which are tolerably transparent to the rays, are also energetic in diffusing them. That the diffusion is not merely from the surface, and not simply diffuse reflection, is shown by the fact that the rays come also from the back of the object and from portions not exposed directly to the rays. This indicates a true opalescence, like that possessed by opal glass in ordinary light. The inference may readily be drawn from this that the shadows of opaque objects embedded in tissue at considerable depths can never be as sharp or black, so to speak, as when the objects are merely surrounded by air. Liquids appear to possess the property as well as solids. It must be borne in mind, also, that the diffusion appears to take place in all directions, within and without the mass of the substance. If the fluorescent screen tube used have thick metal sides, the large metal plate can be dispensed with. In this case it suffices that the screen tube be turned at right angles to the path of the rays or to direct it away from the Crookes tube in a line at an angle with the course of the rays. Pieces of various substances may now be placed opposite the end of the screen tube, but in a position to be partially or wholly exposed to the Roentgen rays. The pieces will become virtual sources of rays, and the diffused rays reaching the fluorescent screen will cause it to emit light.

By placing two exactly similar fluorescent screens at opposite ends of a dark tube, and employing a Bunsen photometer screen movable between them, a comparison of diffusing power of pieces of different materials might easily be made by subjecting the materials placed at the ends of the tube, respectively, to equal radiation from the Crookes tube. In fact, the relative effectiveness of two Crookes tubes as producers of the rays could be tested by such a "fluorometer" by passing the same discharge through both while they were opposite the ends of the "fluorometer." The comparative values of different fluorescent screens could also be tested by slight modifications in the use of the instrument.

The practical bearing of this property of diffusibility of Roentgen rays is found in the consideration that, in making images or shadows of bone structures, or opaque objects when a considerable depth of fleshy layer exists between the objects and the sensitive plate, there must of necessity be a blurring or lessening of contrast, owing to diffusion of the rays into the space back of the opaque bodies. Indeed, by using the fluorescent screen tube, it is easy to note that the shadow of a piece of sheet lead is very black when near the screen, although there may be a block of wood, paraffine, or the like, between the lead and the Crookes tube. But the shadow obtained when the wood or paraffine is between the lead and the fluorescent screen is not black, but somewhat milky, thus showing diffusion.

The writer has not tried the experiment, but thinks that a cloud in the air, or mass of fine particles of condensed water from a steam jet, would diffuse the rays. The higher-pitch light waves are most readily diffused and absorbed by fog, and if Roentgen rays be considered as very high-pitch waves, similar to light waves, this diffusibility should not surprise us. The new rays seem to be detectors of molecular turbidity, so to speak.

Whether true gases have the power of diffusing the rays is not known, but the diffusive power, if it exists at all, is probably very small in such cases.

There was apparently a minimum of diffusive action given by an exhausted incandescent lamp bulb, and what action there was probably came from the glass and may have been reflective.

The metal plates tried gave apparently little diffusive effect, but appeared to reflect feebly at angles equal to the incidence angles. The fluorescence of reflection from surfaces has been worked upon by Mr. Tesla, and a number of figures given of the relative reflecting powers of metals, etc., tried.

The diffusive action herein noted is different altogether from reflection, and is obtained at all angles with the surfaces of the material upon which the rays fall.

* Opalescence in this article is used to mean milkiness or cloudiness, not a play of colors.

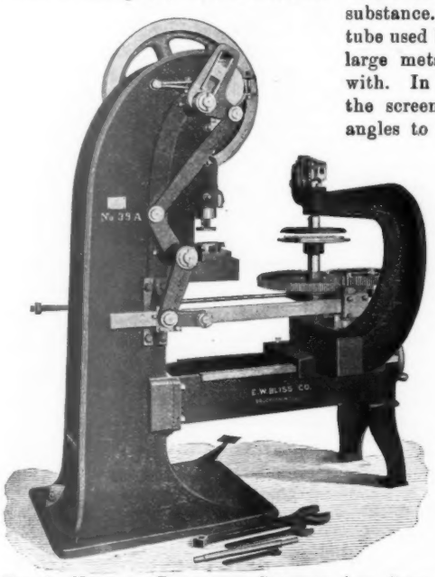


FIG. 1.—NOTCHING PRESS WITH CLAMPING ARM, SHOWING RACK AND PINION MECHANISM.

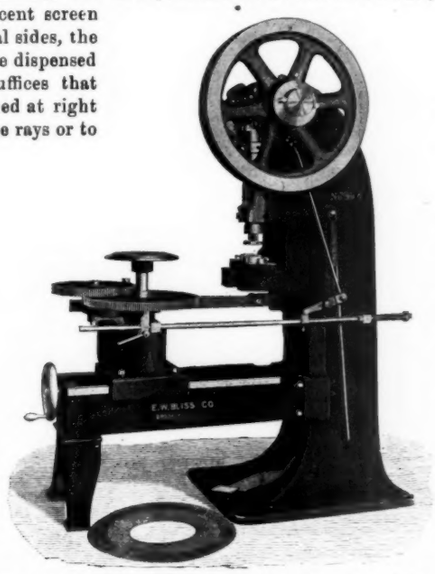


FIG. 2.—NOTCHING PRESS WITHOUT CLAMPING ARM, SHOWING AUTOMATIC STOP.

New Press for Notching Armature Disks.

The well known press and die manufacturers, the E. W. Bliss company, 17 Adams street, Brooklyn, N. Y., are calling attention to a press of entirely new design for notching armature core disks, for which they claim superiority in several important respects over other machines for the same purpose. The machine is well illustrated by the accompanying half-tone engravings.

The adjustment for different diameters is made by simply turning the hand-wheel shown. No alteration or readjustment of pawls or indexing parts to suit different diameters is required.

The adjustment for different numbers of notches is effected by means of change-gears instead of the usual pawl and index-plate device. One gear only need be substituted to obtain any desired alteration in the number of notches. This obviates the necessity of using a special indexing plate for each style of disk, and effects a considerable saving, as the change-gears are comparatively inexpensive. If one notch is punched at each stroke, the number of teeth in the gear corresponds to the number of notches in the disk. If two or three notches are punched simultaneously, the number of teeth in the gear is made one-half or one-third, respectively, of the number of notches.

Two standard sizes are being introduced, designated by the makers as No. 16 A and No. 39 A. No. 16 A weighs about 1,500 pounds, and will take disks of from three inches to 30 inches in diameter. It is designed to be run at a high rate of speed—from 60 to 200 strokes per minute, according to the work being done. The larger machine, No. 39 A, weighs about 2,800 pounds. It will take disks of from five inches to 48 inches in diameter, and may be run at about 100 strokes per minute. For very large disks the No. 39 A machine is built with an extra large clamping and indexing frame, so constructed that it will take disks of from 10 inches to 60 inches.

A Department of Commerce and Manufactures.

A bill which provides for the establishment of a Department of Commerce and Manufactures was introduced in the United States Senate on March 9, by Senator Frye, and was referred to the Committee on Commerce, in whose hands it now rests. This measure is one of great importance to the manufacturing and commercial interests of this country, and there is need for vigorous and immediate support of the bill by those whose interests it directly affects. To secure any action by the committee, or to obtain even a hearing upon the bill, it must be demonstrated to the members of the committee that the business men of the country are in favor of such legislation.

The ELECTRICAL REVIEW believes this movement is worthy of careful consideration, and suggests that its readers send to the National Association of Manufacturers, 1748 North Fourth street, Philadelphia, for free circulars of information on this subject, which is of undoubted importance to the electrical field.

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SPECIAL NOTICE TO ADVERTISERS.

***CHANGES** for advertisements must be in this office by Friday noon for the following week's issue.*

***NEW ADVERTISEMENTS** should be in the office not later than Saturday noon to insure publication the following week.*

NEW YORK, APRIL 22, 1896.

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There will be a lively gathering of the electrical fraternity in the metropolis next month. New York will extend a cordial welcome to these progressive visitors. May their stay be pleasant and profitable.

The contemplated combination of the General Electric Company's factories near Elizabeth, N. J., would be one of the wisest moves that that company could make. According to our news on the opposite page, it means that the company would be given a brand new manufacturing plant costing $1,000,000 and a cash bonus of $575,000. They would still hold their old plants at Schenectady, Lynn and Harrison as assets. It is to be hoped that every obstacle to the deal being completed may be removed. The company would make a considerable saving in its manufacturing cost besides securing other and equally important advantages.

Tesla's latest investigations of the many interesting scientific questions arising from the Roentgen ray discovery are published in this issue. No step in the various stages that he has so far presented to the readers of the ELECTRICAL REVIEW is more interesting or suggestive. The relation which he demonstrates to exist between the series obtained by arranging the metals according to their reflective power and Volta's contact series in air, proves that the rays emitted from the bulb are not an isolated phenomenon, but are emitted everywhere. Particularly suggestive is the observation that all conductors emit streams similar to those discovered by Roentgen, and that the sun and other sources of radiant energies must pour forth rays of the nature of the cathode. To those devoted chiefly to the practical applications of Roentgen's discovery, Tesla's latest observations with a fluorescent screen, showing that even the heart can be seen, will appear most promising, while his investigation of the important effect discovered by Prof. J. J. Thomson (who has contributed so much to the advancement along these lines) can not fail to be of the greatest interest to scientific men.

THE PATENT COMMITTEE COMPLETED.

Mr. E. B. Thomas, president of the Erie Railroad Company, has been selected as the fifth member of the committee to manage the patents of the General Electric-Westinghouse alliance. As Mr. Thomas is a very busy man, it was necessary to appoint an alternate to serve in case of his absence. The alternate has been selected in the person of Mr. Samuel Spencer, president of the Southern Railway Company.

Both Messrs. Thomas and Spencer are eminently able and fair-minded men, and were agreed upon unanimously by the General Electric and Westinghouse interests.

These appointments complete the committee. The four original members were named in the ELECTRICAL REVIEW for March 25, just a month ago. They are Messrs. C. A. Coffin and F. P. Fish, representing the General Electric Company, and George Westinghouse, Jr., and Paul D. Cravath, representing the Westinghouse Electric and Manufacturing Company. It is fair to presume that these gentlemen will administer the patent affairs of the two great corporations named in a just and impartial manner. It is understood that the committee has taken offices at 120 Broadway, New York city, at which address its business will be transacted.

TESLA'S LATEST ROENTGEN RAY INVESTIGATIONS.

TO THE EDITOR OF ELECTRICAL REVIEW:

Further investigations concerning the behavior of the various metals in regard to reflection of these radiations have given additional support to the opinion which I have before expressed; namely, that Volta's electric contact series in air is identical with that which is obtained when arranging the metals according to their powers of reflection, the most electro-positive metal being the best reflector. Confining myself to the metals easily experimented upon, this series is magnesium, lead, tin, iron, copper, silver, gold and platinum. The last-named metal should be found to be the poorest, and sodium one of the best, reflectors. This relation is rendered still more interesting and suggestive when we consider that this series is approximately the same which is obtained when arranging the metals according to their energies of combination with oxygen, as calculated from their chemical equivalents.

Should the above relation be confirmed by other physicists, we shall be justified to draw the following conclusions: *First*, the highly exhausted bulb emits material streams which, impinging on a metallic surface, are reflected; *second*, these streams are formed of matter in some primary or elementary condition; *third*, these material streams are probably the same agent which is the cause of the electro-motive tension between metals in close proximity or actual contact, and they may possibly, to some extent, determine the energy of combination of the metals with oxygen; *fourth*, every metal or conductor is more or less a source of such streams; *fifth*, these streams or radiations must be produced by some radiations which exist in the medium; and *sixth*, streams resembling the cathodic must be emitted by the sun and probably also by other sources of radiant energy, such as an arc light or Bunsen burner.

The first of these conclusions, assuming the above-cited fact to be correct, is evident and uncontrovertible. No theory of vibration of any kind would account for this singular relation between the powers of reflection and electric properties of the metals. Streams of projected matter coming in actual contact with the reflecting metal surface afford the only plausible explanation.

The second conclusion is likewise obvious, since no difference whatever is observed by employing various qualities of glass for the bulb, electrodes of different metals and any kind of residual gases. Evidently, whatever the matter constituting the streams may be, it must undergo a change in the process of expulsion, or, generally speaking, projection—since the views in this regard still differ—in such a way as to lose entirely the characteristics which it possessed when forming the electrode, or wall of the bulb, or the gaseous contents of the latter.

The existence of the above relation between the reflecting and contact series forces us likewise to the third conclusion, because a mere coinci-

dence of that kind is, to say the least, extremely improbable. Besides, the fact may be cited that there is always a difference of potential set up between two metal plates at some distance and in the path of the rays issuing from an exhausted bulb.

Now, since there exists an electric pressure or difference of potential between two metals in close proximity or contact, we must, when considering all the foregoing, come to the fourth conclusion, namely, that the metals emit similar streams, and I therefore anticipate that, if a sensitive film be placed between two plates, say, of magnesium and copper, a true Roentgen shadow picture would be obtained after a very long exposure in the dark. Or, in general, such picture could be secured whenever the plate is placed near a metallic or conducting body, leaving for the present the insulators out of consideration. Sodium, one of the first of the electric contact series, but not yet experimented upon, should give out more of such streams than even magnesium.

Obviously, such streams could not be forever emitted, unless there is a continuous supply of radiation from the medium in some other form; or possibly the streams which the bodies themselves emit are merely reflected streams coming from other sources. But since all investigation has strengthened the opinion advanced by Roentgen that for the production of these radiations some impact is required, the former of the two possibilities is the more probable one, and we must assume that the radiations existing in the medium and giving rise to those here considered partake something of the nature of cathodic streams.

But if such streams exist all around us in the ambient medium, the question arises, whence do they come? The only answer is: From the sun. I infer, therefore, that the sun and other sources of radiant energy must, in a less degree, emit radiations or streams of matter similar to those thrown off by an electrode in a highly exhausted inclosure. This seems to be, at this moment, still a point of controversy. According to my present convictions a Roentgen shadow picture should, with very long exposures, be obtained from all sources of radiant energy, provided the radiations are permitted first to impinge upon a metal or other body.

The preceding considerations tend to show that the lumps of matter composing a cathodic stream in the bulb are broken up into incomparably smaller particles by impact against the wall of the latter, and, owing to this, are enabled to pass into the air. All evidence which I have so far obtained points rather to this than to the throwing off of particles of the wall itself under the violent impact of the cathodic stream. According to my convictions, then, the difference between Lenard and Roentgen rays, if there be any, lies solely in this, that the particles composing the latter are incomparably smaller and possess a higher velocity. To these two qualifications I chiefly attribute the non-deflectibility by a magnet which I believe will be disproved in the end. Both kinds of rays, however, affect the sensitive plate and fluorescent screen, only the rays discovered by Roentgen are much more effective. We know now that these rays are produced under certain exceptional conditions in a bulb, the vacuum being extremely high, and that the range of greatest activity is rather small.

I have endeavored to find whether the reflected rays possess certain distinctive features, and I have taken pictures of various objects with this purpose in view, but no marked difference was noted in any case. I therefore conclude that the matter composing the Roentgen rays does not suffer further degradation by impact against bodies. One of the most important tasks for the experimenter remains still to determine what becomes of the energy of these rays. In a number of experiments with rays reflected from and transmitted through a conducting or insulating plate, I found that only a small part of the rays could be accounted for. For instance, through a zinc plate, one-sixteenth of an inch thick, under an incident angle of 45 degrees, about two and one-half per cent were reflected and about three per cent transmitted through the plate, hence over 94 per cent of the total radiation remain to be accounted for. All the tests which I have been able to make have confirmed Roentgen's statement that these rays are incapable of raising the temperature of a body. To trace this lost energy and account for it in a plausible way will be equivalent to making a new discovery.

Since it is now demonstrated that all bodies reflect more or less, the diffusion through the air is easily accounted for. Observing the tendency to scatter through the air, I have been led to increase the efficiency of reflectors by providing not one, but separated successive layers for reflection, by making the reflector of thin sheets of metal, mica or other substances. The efficiency of mica as a reflector I attribute chiefly to the fact that it is composed of many superimposed layers which reflect individually. These many successive reflections are, in my opinion, also the cause of the scattering through the air.

In my communication to you of April 1, I have for the first time stated that these rays are composed of matter in a "primary" or elementary condition or state. I have chosen this mode of expression in order to avoid the use of the word "ether," which is usually understood in the sense of the Maxwellian interpretation, which would not be in accord with my present convictions in regard to the nature of the radiations.

An observation which might be of some interest is the following: A few years ago I described on one occasion a phenomenon observed in highly exhausted bulbs. It is a brush or stream issuing from a single electrode under certain conditions, which rotates very rapidly in consequence of the action of the earth's magnetism. Now I have recently observed this same phenomenon in several bulbs which were capable of impressing the sensitive film and fluorescent screen very strongly. As the brush is rapidly twirling around I have conjectured that perhaps also the Lenard and Roentgen streams are rotating under the action of the earth's magnetism, and I am endeavoring to obtain an evidence of such motion by studying the action of a bulb in various positions with respect to the magnetic axis of the earth.

In so far as the vibrational character of the rays is concerned, I still hold that the vibration is merely that which is conditioned by the apparatus employed. With the ordinary induction coil we have almost exclusively to deal with a very low vibration impressed by the commutating device or brake. With the disruptive coil we usually have a very strong superimposed vibration in addition to the fundamental one, and it is easy to trace sometimes as much as the fourth octave of the fundamental vibration. But I can not reconcile myself with the idea of vibrations approximating or even exceeding those of light, and think that all these effects could be as well produced with a steady electrical pressure as from a battery, with the exclusion of all vibration which may occur, even in such instance, as has been pointed out by De La Rive. In my experiments I have tried to ascertain whether a greater difference between the shadows of the bones and flesh could be obtained by employing currents of extremely high frequency, but I have been unable to discover any such effect which would be dependent on the frequency of the currents, although the latter were varied between as wide limits as was possible. But it is a rule that the more intense the action the sharper the shadows obtained, provided that the distance is not too small. It is furthermore of the greatest importance for the clearness of the shadows that the rays should be passed through some tubular reflector, which renders them sensibly parallel.

In order then to bring out as much detail as possible on a sensitive plate, we have to proceed in precisely the same way as if we had to deal with flying bullets hitting against a wall composed of parts of different density with the problem before us of producing as large as possible a difference in the trajectories of the bullets which pass through the various parts of the wall. Manifestly, this difference will be the greater the greater the velocity of the bullets; hence, in order to bring out detail, very strong radiations are required. Proceeding on this theory I have employed exceptionally thick films and developed very slowly, and in this way clearer pictures have been obtained. The importance of slow development has been first pointed out by Professor Wright, of Yale. Of course, if Professor Henry's suggestion of the use of a fluorescent body in contact with the sensitive film is made use of, the process is reduced to an ordinary quick photographic procedure, and the above consideration does not apply.

It being desirable to produce as powerful a radiation as possible, I have continued to devote my attention to this problem and have been quite successful. First of all, there existed limitations in the vacuum tube which did not permit the applying of as high a potential as I desired; namely, when a certain high degree of exhaustion was reached a spark would form behind the electrode, which would prevent straining the tube much higher. This inconvenience I have overcome entirely by making the wire leading to the electrode very long and passing it through a narrow channel, so that the heat from the electrode could not cause the formation of such sparks. Another limitation was imposed by streamers which would break out at the end of the tube when the potential was excessive. This latter inconvenience I have overcome either by the use of a cold blast of air along the tube, as I have mentioned before, or else by immersion of the tube in oil. The oil, as it is now well known, is a means of rendering impossible the formation of streamers by the exclusion of all air. The use of the oil in connection with the production of these radiations has been early advocated in this country by Professor Trowbridge. Originally I employed a wooden box made thoroughly tight with wax and filled with oil or other liquid, in which the tube was immersed. Observing certain specific actions, I modified and improved the apparatus, and in my later investigations I have employed an arrangement as shown in the annexed out. A bulb *b*, of the kind described before, with a leading-in wire and neck much longer than here shown, was inserted into a large and

(Concluded on page 211.)

GENERAL ELECTRIC FACTORIES TO BE MOVED.

THE SCHENECTADY, LYNN AND HARRISON PLANTS TO BE CLOSED —THE FINEST ELECTRICAL MANUFACTURING PLANT IN THE WORLD TO BE ERECTED FOR THE COMPANY NEAR ELIZABETH, N. J. —A DEAL OF LARGE PROPORTIONS.

The ELECTRICAL REVIEW is credibly informed from several sources that the General Electric Company will close its large factories at Schenectady, N. Y.; Lynn, Mass., and Harrison, N. J., and will remove its entire manufacturing business to a new and modern plant to be erected for the company near Elizabeth, N. J.

The deal is one of great magnitude and has been hanging fire for over a year and a half. Nearly all the obstacles to its successful accomplishment have been disposed of, and it is expected that the final arrangements may be concluded this week.

The idea had its origin with a syndicate of Elmira, N. Y., and western capitalists, who have made several successes with improvement and industrial exterprises involving heavy land transactions. These gentlemen have formed the New Orange Industrial Association with handsome headquarters at 253 Broadway, New York city. Mr. C. W. Manahan is general manager of the company. Mr. Matthew Arnot, a very wealthy banker of Elmira, is heavily interested in the company, and is understood to be ready to supply any amount of money to carry out the proposed project. He is credited with being worth $15,000,000.

The New Orange Industrial Association has acquired a tract of land lying between Elizabeth and South Orange, N. J., aggregating five square miles in area. Five prominent railroads cross this tract of land. The scheme includes the building of a standard gauge electric belt line railroad connecting the five steam roads.

In order to make this tract of land valuable, it was necessary for the New Orange Industrial Association to attract manufacturers, and to that end the company is said to have made a most liberal offer to the General Electric Company. This offer is stated to include the following: The land company will build, to the value of $1,000,000, a manufacturing plant after the General Electric Company's own designs, the plant to be turned over in fee simple to the General Electric Company on its completion. The land company is to give the electric company a cash bonus of $400,000 and a further allowance of $175,000 for moving expenses. The old factories belonging to the General Electric Company remain their property, and in time may be sold or leased for a considerable sum.

The combination of the company's manufacturing interests in one place means that 10,000 or more hands will find employment in their factories, and a good-sized town will be required to accommodate the workmen and their families. It is judged that the General Electric Company, by this move, can reduce its manufacturing expenses at least 10 per cent and gain besides the advantages of shipping freight over five of the principal railroads.

THE NATIONAL ELECTRICAL EXPOSITION.

SOME OF THE PROPOSED EXHIBITS.

Great interest is being manifested by manufacturers and others in all parts of the country in the National Electrical Exposition, which is scheduled to open on May 4, in the Industrial Building, Lexington avenue and Forty-third street, New York city. Following will be found further particulars of some of the proposed exhibits:

The Mica Insulator Company, New York city, will exhibit their mica and micanite insulating specialties.

The Crocker-Wheeler Electric Company, New York city, will make a comprehensive exhibit in their special field of work.

Spon & Chamberlain, the well known publishers, of New York city, will display electrical and scientific books and publications. Both members of the firm will attend the Exposition.

The new type of armature disk notching press, manufactured by the E. W. Bliss company, Brooklyn, N. Y., will be exhibited in connection with the Crocker-Wheeler dynamo.

The Goubert Manufacturing Company, New York city, will display their steam specialties in a space they have taken, and will show others as a working exhibit in connection with other apparatus.

The Watertown Steam Engine Company, Watertown, N. Y., will exhibit a 10x12-inch, high-speed engine direct connected to an Eddy dynamo. Messrs. Robert E. Cahill and L. Copleston will be in charge of the exhibit.

The Columbia Rubber Works Company, New York, will show a line of hard rubber specialties, such as hard rubber sheet, rod and tubing, telephone receivers and push buttons. They will also exhibit a new fireproof compound.

The Fuel Economizer Company, Matteawan, N. Y., will exhibit sample castings of their economizer, photographs, blue-prints and various plans of boiler houses showing the various applications of their economizers in plants now working.

The Kennedy Valve Manufacturing Company, New York city, will display a line of extra heavy gate valves, especially designed to meet the requirements of modern power plants. They will also show a line of their standard gate and globe valves.

The Bradford Belting Company, Cincinnati, will exhibit their dynamo belting and Monarch insulating paint, of which they are the sole manufacturers. Messrs. E. F. Bradford, O. M. Hubbard and E. P. Morris will be present during the Exposition.

The Harrisburg Foundry and Machine Works, Harrisburg, Pa., will exhibit a 12x12-inch Ideal engine direct connected to a 40-kilowatt Eddy generator. W. R. Fleming & Company, of New York, will represent the Harrisburg people at the Exposition.

Chas. A. Schieren & Company, New York city, will exhibit their specialties in the electrical line, consisting of large three-ply and double main driving belts, and smaller sizes for use on street railway generators and electric light dynamos and all high-speed work.

The Riker Electric Motor Company, Brooklyn, N. Y., will exhibit several of their new fan motors, standard Riker machines and a direct-connected plant, consisting of a Riker dynamo and a Case engine. The latter is similar to those the company installs for yacht-lighting.

The Nowotny Electric Company, Cincinnati, will show their ironclad motors and dynamos and a number of entirely new electric light specialties of their own manufacture. President L. R. Keck, General Manager John S. Nowotny, and Mr. Wm. M. Venable will be present.

The Phœnix Iron Works Company, Meadville, Pa., will exhibit a Dick & Church tandem compound, non-condensing, automatic cut-off engine of 125 horse-power, direct connected to a 75-kilowatt Walker generator. Mr. C. A. White, of the company's New York office, will have general charge of the exhibit.

The Straight Line Engine Company, Syracuse, N. Y., will show a 13x15-inch, 125-horse-power engine direct connected to a 75-kilowatt General Electric dynamo and a 10x14-inch, 80-horse-power engine direct connected to a Crocker-Wheeler dynamo. The latter engine, it is understood, will be driven by compressed air.

The Ashcroft Manufacturing Company, New York city, will have a prominent exhibit of consolidated safety valves, Metropolitan injectors, Mocrop recorders, and Edson pressure recording gauge. The manufacturing privilege for the latter, this company have recently secured. This exhibit will probably be one of the most interesting in the line of steam specialties.

The Electrozone Company, New York city, intend to exhibit a working model manufacturing electrozone, a working model showing the Woolf process of bleaching wood pulp by electricity, and a working model showing the Woolf process of manufacturing caustic soda by electrolysis. The potency of the electrical disinfectant will be shown by killing infusoria and the lower forms of animal germ life.

Stanley & Patterson, of New York, will display a line of general electric light and electric bell supplies. As eastern agents they will represent the New York & Ohio company, manufacturers of Packard lamps; Brunt & Thompson, manufacturers of porcelain goods; Indiana Rubber & Insulated Wire Company, manufacturers of Paranite wire, and the E. G. Bernard company, manufacturers of dynamos and motors. Messrs. Stanley, Patterson, Mead and Mays will be in attendance.

The E. T. Burrowes Company, Portland, Me., will exhibit models showing several styles of their automatic curtains for electric railway cars. They will also show a new waterproof curtain material called Oakette. Another part of their exhibit will be a cable device for holding curtains on an open car in place and a pinch handle device for an inside shade. While this exhibit will be small, the company will endeavor to make it interesting, as the curtain equipment of a car is by no means its least important feature.

The Standard Underground Cable Company, Pittsburgh, will exhibit a few reels of cable showing their standard fiber insulation and a specialty will be made of samples representing some of their most important recent contracts. There will also be a show rack for wires and cables and especially for small samples of lead-covered cable for distribution. Manager G. L. Wiley, of New York, and an assistant will attend the exhibition regularly, and Vice-president Marsh, of Pittsburgh, and Manager J. R. Wiley, of Chicago, will be present several days. The Standard company will distribute a novel electrical souvenir.

Hugo Reisinger, New York city, will make an extensive carbon exhibit, consisting of "Electra" high-grade Nuernberg carbons for arc lighting, for direct-current arc lamps on incandescent circuits, and for alternating current arc lamps; all descriptions of the finest grade of microphone carbons used in the manufacture of telephones; all descriptions of the very finest grades of battery carbons, and carbons used for search-lighting, for the manufacture of aluminum and for smelting all kinds of ores. Messrs. J. F. Outwater and Fred Nolker will represent Mr. Reisinger at the Exposition.

The exhibit of the Card Electric Motor and Dynamo Company, Cincinnati, will consist, in part, of the following apparatus: One 25-kilowatt generator directly connected to a Payne high-speed, automatic engine; a motor operating a Hoe press, the armature of the motor being directly connected to the shaft of the press in the place of the pulleys; a motor directly connected to a 37-inch Niles boring mill; a motor directly connected to a Niles six-foot radial drill and a three horse-power motor belted to a horizontal boring mill. They will also supplement their exhibit with some other special features which have as yet not been definitely decided upon.

In view of the importance of the occasion, the exhibit of the United States Patent Office at the National Electrical Exposition will be made one of unusual size and interest. As now arranged by the department, under the instructions of Mr. S. T. Fisher, the acting commissioner, it will include no fewer than 361 separate models of electrical devices, apparatus, machinery and appliances, many of them embodying the fundamental and elementary ideas upon which the modern electrical arts have been founded. These models will occupy over 300 linear feet, and will be carefully grouped and classified, so that students of whatever character can follow the general lines of growth or evolution.

The Partrick & Carter Company, Philadelphia, will exhibit a general line of house goods, consisting of hotel and house annunciators, burglar alarms, hotel fire-alarm systems and return calls, and also a full assortment of bells, pushes and numerous other household electrical appliances. They will have in operation a complete line of their own goods, and it is their intention, if possible, to have on hand, during the entire time of the exhibition, thoroughly competent attendants. They will call in from the road two or three of their most important salesmen, among them Mr. Thos. L. Townsend, who is known to the general trade from Maine to California, to be on hand to visit the firm's many friends who visit the Exposition. It is also the intention of the members of the firm to be at the Exposition as much as they can conveniently.

The General Electric Company will occupy 400 feet of space fitted up as a headquarters and general reception room. They will show, as a still exhibit, a number of their latest long burning arc lamps, a selection of inclined coil instruments and a few meters. They expect to have a representative collection of bromide prints illustrating the company's latest types of apparatus and photographs of representative installations. The Convention Committee of the company, consisting of S. D. Greene, chairman; Chas. T. Hughes, vice-chairman; Fred M. Kimball, secretary; A. D. Page, lamp works; T. Beran, of the New York Supply Department, and F. N. Boyer, of the Chicago Supply Department, will probably be present during the entire convention. Messrs. H. J. Buddy, representing the Philadelphia office; A. F. Giles, representing the Atlanta office; W. J. Ferris, representing the Chicago office, and Messrs. Chas. B. Davis, A. R. Bush, C. S. Haley and A. W. Ives, representing the Boston office, together with representatives from the railway, power, and mining departments and the New York office, will attend.

Keuffel & Esser company, New

York city, will show a handsome collection of drawing instruments and supplies and surveying instruments, such as are used in electric railway construction.

The C. W. Hunt company, New York city, will show Hunt's noiseless and frictionless conveyor adapted to the service of boilers in power stations. Mr. Harry P. Barr will be in charge of the exhibit.

Huebel & Manger, Brooklyn, N. Y., will make a handsome display of their electrical and brass goods. Mr. W. W. McChesney, Jr., will be in charge, and the members of the firm will be present to welcome their friends.

The Birdsall Electric Manufacturing Company, of New York city, will show a novel line of combination electrical specialties, which will undoubtedly attract attention. A few of them were recently described in the ELECTRICAL REVIEW.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., will exhibit a two-phase S. K. C. generator, a two-phase alternating current motor, transformers and switchboard apparatus. Mr. T. E. Theberath, the company's New York representative, will have charge of the exhibit.

The Peru Electric Manufacturing Company, Peru, Ind., will make a complete display of all the different pieces of porcelain which they manufacture, together with an exhibition of their Laclede and Hercules batteries. Messrs. Bouslog, Schutt and Stevens will be in charge of the exhibit.

The Crane company, New York city, will show samples of their extra heavy I. B. gate valves for 200 pounds working pressure, extra heavy I. B. globe and angle valves for 200 pounds working pressure, standard and indicator valves, iron body blow-off valves, extra heavy flanged fittings for 200 pounds working pressure, and samples of many of their smaller specialties, such as brass valves, Pope safety valves, water relief valves and the like.

The Interior Conduit and Insulation Company, New York city, have secured a large space and will show in operation a printing press run by a direct-connected Lundell motor, exhaust fan outfits, 60 inches, 36 inches and 12 inches; direct-connected generating set, Lundell power motors, Lundell generators, Lundell desk-fan motors and ceiling-fan motors, Lundell dental outfits, Lundell emery wheel grinder, Lundell buffing machine and Lundell organ-blowing outfit. The latter outfit will be attached to a Mason & Hamlin organ, which will be played each evening. The company will also exhibit their complete system of plain, brass-armored and iron-armored insulating conduits as well as their complete underground conduit system. An illuminated sign 30 feet in length will be shown. The following-named gentlemen will be in attendance and explain the various novelties: Messrs. D. C. Durland, Geo. H. Kimber and E. B. Kittle.

In connection with the opening ceremonies of the National Electrical Exposition, when it is proposed to start the machinery by a circuit that has first looped in the whole continent, the Postal Telegraph Cable Company, through its vice-president, Mr. W. H. Baker, has very courteously offered its fine service between New York and San Francisco for the purpose. The Postal company has been equipping its lines with heavy copper circuits and believes that it can illustrate rapidity of working by the instantaneity of its transmission on May 4, when the mere pressure of the golden key will flash the signal to the golden gate and back to the Exposition building in the twinkling of an eye. Arrangements are now being made with the Postal officials for the execution of this interesting plan, with the co-operation of the long string of offices scattered over the 6,000 miles of wire.

J. C. Vetter & Company, New York city, will make an exhibit to demonstrate the application of the constant incandescent current in electro-therapeutics, by means of various instruments designed for the purpose. This apparatus consists of the following: Vetter current tap, by means of which the current from any lamp socket can be carried to a drop-light or fan motor without interfering with the lamp; current adapter, by means of which the lamp in the socket can be placed in series, and the current thus reduced and limited by the capacity of the lamp; carbon current controller; volt controller; standard milliammeter; cautery rheostat and various combinations of the above apparatus in the way of table bases, switchboards and cabinets. A feature of this exhibit will be a cabinet lately designed, which, in connection with the constant incandescent current, furnishes for electro therapeutical purposes the galvanic current, faradic current, sinusoidal current, cautery current, motor current and current for small diagnostic lamps. All these currents can be modified and manipulated to the finest degree. Mr. A. F. Vetter will attend the Exposition.

The Payne Engine Company, of 41 Dey street, New York city, and Elmira, N. Y., will have one of their new type direct-connected engines of 50-horse-power capacity connected to a 25-kilowatt card generator. This machine will undoubtedly be of unusual interest, from the fact that it will have an improved inertia governor of an exceedingly simple form of construction, and one for which is claimed very superior results. The governor consists of but two pieces and one bearing, thus reducing friction to the minimum and the chances of disarrangement. It is stated by manufacturers that this governor will move through the entire range, viz., from 0 to 5/6 cut-off in less than one-fifth of a second, and it overcomes what is commonly known as "dancing" in the centrifugal governor. The Payne people will have another feature which will attract a good deal of attention. It is an automatic return oil circulation system, by means of which the oil is delivered in a stream to the main bearings by gravity, and drained to a central point at the bottom of the base. By means of a small oil pump working on the rocker arm of the valve rod, it is pumped to the receptacle on top of the frame, where it is filtered and reused. Carefully designed oil guards prevent any oil being thrown from the engine; and at the same time it is not the inclosed type. The Payne company will be represented at the Exposition by S. H. Payne, N. B. Payne and F. N. Jewett, of the New York office.

SOCKETLESS DECORATIVE INCANDESCENT LAMPS.

Realizing the impracticability of adequately exhibiting the working of its complicated and extensive plant in any reasonable space, the Metropolitan Telephone and Telegraph Company will make an exhibit illustrative of its New York city service as viewed from the user's standpoint. The manner in which this will be carried out involves, nevertheless, a more elaborate installation than might appear from the exhibit proper, as the company will place telephone stations at a number of exhibitors' spaces, as well as at points where service is desired by the Exposition company. These stations will be connected to a switchboard in the company's space, thus forming a small exchange within the exhibition itself. This service will be furnished without charge to the exhibitors and to the Exposition company by the Metropolitan Telephone Company, which will furnish the entire installation and maintain the service at its own expense. Besides the switchboard, the company will install in its own space four silence booths of different types, each equipped with telephone instruments of the various styles used by New York city subscribers. These will all be working stations connected with the Thirty-eighth street exchange and will be available to visitors to the exhibition in the same way as an ordinary public pay station. This remarkably useful form of exhibit will no doubt be highly appreciated by exhibitors who can not fail to realize the convenience of being placed in easy communication with each other and with their home offices. The exhibit proper will afford the public ample illustration of the excellent service furnished by the Metropolitan company and of the high grade of equipment provided for public and subscribers' stations. Those visitors who display particular interest in the operation of a city telephone system will be invited to visit one of the company's large exchanges, where they can examine in detail the nature and operation of the plant, which are practically impossible of reproduction in an ordinary exhibition.

PERSONAL.

Mr. C. M. Morse, of the Buffalo Engineering Company, Buffalo, N. Y., visited New York city last week.

Mr. Albert L. Johnson, of Cleveland, has been elected president of the Nassau Electric Railway Company, of Brooklyn, N. Y.

Among the out-of-town electrical men who visited New York city last week were Messrs. Estep, of Pittsburgh; C. J. Mayer, of Philadelphia, and Louis Myer, of Chicago.

Mr. P. H. W. Smith has been appointed assistant general manager of the Standard Underground Cable Company. Mr. Smith's training in electrical matters was received at Lehigh University, of which he is a graduate. He has been actively connected with the Standard Underground Cable Company for a number of years in the construction and sales departments, and the advancement is well merited and will be appreciated by his many friends. Mr. F. S. Viele has been made manager of the conduit and the general construction departments. Mr. Viele is a graduate of Massachusetts Institute of Technology in Electrical Engineering, and his ability in matters pertaining to insulated wires and cables makes him a valuable man for the company.

A Socketless Decorative Lamp.

The Empire Lamp Works, 154 and 156 West Twenty-seventh street, New York city, have just placed upon the market a series decorative incandescent lamp with which no socket is required. The accompanying illustration shows the lamps half size. They are made for three candle-power to run four in series on 50 to 60 volts, and eight in series on 110 to 120 volts. The lamps are especially suitable for decorative and display effects, and when hung in chains and festoons present a very beautiful appearance.

"I tell you what," said a fat, red-faced man as he stood in Park Row one evening last week; "I was just going to take that horse-car there, but I didn't, not on your tin-type, when I saw the sign in the window."

"What was it?" asked a friend.

"What was it?" repeated the fat man, scornfully. "What was it? It was 'This car is heated.' These horse car managers must be gibbering idiots."

THE HISTORY OF ELECTRIC HEATING APPLIED TO METALLURGY.

READ BEFORE THE WASHINGTON SECTION OF THE AMERICAN CHEMICAL SOCIETY BY FREDERIC P. DEWEY.

(Concluded from page 193.)

In 1887–88 a series of patents was granted to M. P. L. T. Heroult, in which alumina was melted by the passage of the current and then electrolyzed with molten copper, or iron, as the cathode with which the separated aluminum alloyed.

The furnace (Fig. 8) was a suitable containing vessel of carbon to which the negative wire was attached. The positive electrode was of carbon. In running the furnace, copper or iron was first put in and melted by the current, then alumina was added, which was also melted and then electrolyzed by the current. More alumina and copper, or iron, were added from time to time, and the resulting alloy was tapped out periodically.

This was a very promising high heat alloying process, but it, as well as the Cowles process, was superseded in the aluminum field by the Hall process of producing the pure metal, of which it is only necessary to say here that in this process the charge is both melted and electrolyzed by the current, but the fact is to be emphasized that only a comparatively low temperature is required.

From 1892 to March 15, 1895, there has been much published regarding the work of M. Henri Moissan, who has done so much fine work in the field of high temperatures, and has accomplished such wonderful results.

He employed various styles of furnaces and different amounts of current. His early furnace (Fig. 9) consisted of a simple block of quicklime suitably bound and provided with electrodes and a cover. In this, some very interesting results were obtained. Another furnace (Fig. 10) was especially designed for determining the temperature by the specific heat method. A piece of carbon was put on the end of one electrode, the current passed and the carbon pushed off from the electrode; at the same time a slide was withdrawn from the bottom of the furnace and the hot carbon allowed to fall in the calorimeter below. A number of temperature determinations were made in connection with M. Violle. Another furnace (Fig. 11) was provided with tubes for the introduction of gases. In this, pure and colorless carbide of silicon was formed from carbon and silicon vapors. This furnace also had various layers, beginning with lime on the outside, and followed by carbon and then magnesia on the inside, or vice versa. Another furnace (Fig. 12) had transparent ends of glass, or mica, so that the operations could be watched. It also had magnets to direct and control the arc.

In this, Moissan designed to investigate and study the simple heating effect of the current separated as much as possible from any electrolytic effect. He speaks of and treats the arc as one would speak of an ordinary flame.

Moissan began with a very moderate current of 35 to 40 amperes at 55 volts, and passed through various stages up to 1,200–1,600 amperes at 110 volts.

A few of the results obtained by Moissan may be mentioned. Magnesia was the only irreducible oxide found; it was melted and volatilized. Lime, strontia and magnesia began to volatilize before melting. Lime was easily melted and the metal calcium reduced, but it immediately combined with the carbon vapor, forming calcium carbide (CaC). Alumina and platinum were volatilized. Artificial diamonds were produced. Various temperatures from 2,000 degrees to about 3,800 degrees centigrade were measured. Carbon begins to volatilize at about 3,500 degrees centigrade. Various quantities of the rarer metals were reduced 200 to 300 grammes of uranium; 100 grammes of vanadium; 10 kilos of chromium, as well as manganese.

As in practical flame work, the amount of fuel burned determines the temperature of the furnace, so in this case the amount of current passed determines the temperature and the furnace must be designed to stand the current to be employed. While Moissan's small furnace will stand the temperature developed by small currents, yet with 1,200 amperes at 110 volts the lime and magnesia melt down, volatilize rapidly, and in a few moments the furnace is spoiled at a temperature of about 3,500 degrees centigrade.

For materials of construction it was found that lime was the best non-conductor for heat, but its fusibility and the ease of forming the carbide prevent its use for the inside of the furnace at very high temperatures. Compared with lime, carbon is a good conductor of heat. Magnesia is also a better heat conductor than lime. It does not form carbide of magnesium, and therefore can be heated very hot in direct contact with carbon, while lime can not. It, however, is volatile, and can be melted at very high temperature. Practically, therefore, the outside of the furnace is quicklime, while the interior is variously lined with carbon or magnesia, or both, and when carbon is in direct contact with the lime it must not get too hot at the point of contact.

In 1893 a United States patent, No. 492,767, was issued to E. G. Acheson, in which a mixture of silica, carbon and salt was heated by the passage of the current, and silicon carbide produced, which has found considerable application as an abrasive.

In the present early stage and activity of the calcium carbide and barium carbide questions, it might not be wise to go into the details of the work and the claims of the various workers (Borscher, Maquenne, Moissan, Travers, Willson—I arrange these names simply alphabetically), but I mention these various carbide processes to show the present condition of our subject, and to draw especial attention to a notable fact.

In reviewing our subject we find that in the early days the current was suggested, tried and used for various metallurgical operations, in which both the heating and decomposing actions of the current were utilized. Then in the principal, practical part of the field, that of the production of sodium and aluminum, the generation of intense temperatures became paramount. This activity culminated in the high heat processes of Cowles and Heroult, and they were very soon superseded by the low temperature process of Hall for the production of aluminum, which carried with it the greater part of the demand for the production of sodium.

At the present day, therefore, there is no practical production of metals by high electric heats, with the possible exception of the production of chromium. On the other hand, high electric heats are being employed to go a step beyond the reduction of the metals, and to form new compounds, as in the carbide processes mentioned. In these the metals are first reduced and are then immediately recombined with carbon, and thus in the field of high heat our subject becomes the application of high electric heat to chemistry.

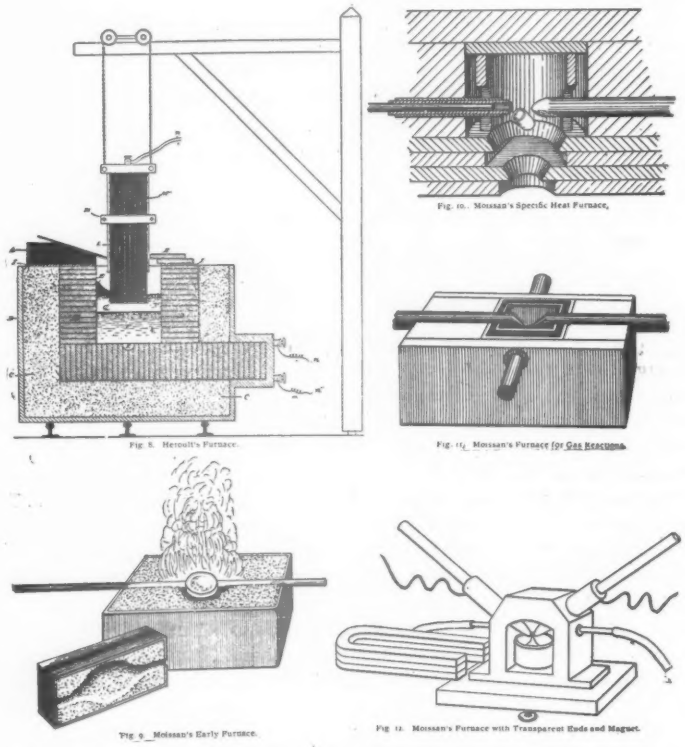


Fig. 8. Heroult's Furnace.
Fig. 9. Moissan's Early Furnace.
Fig. 10. Moissan's Specific Heat Furnace.
Fig. 11. Moissan's Furnace for Gas Reactions.
Fig. 12. Moissan's Furnace with Transparent Ends and Magnet.

ELECTRIC FURNACES MENTIONED IN "THE HISTORY OF ELECTRIC HEATING APPLIED TO METALLURGY."

Medico-Legal Society.

At the monthly dinner of the Medico-Legal Society, held at the Hotel Marlborough, New York city, on April 15, Dr. J. Mount Bleyer read a paper on "The Roentgen Rays in Medico-Legal Surgery."

TELEPHONE NEWS AND COMMENT.

There are said to be 150 opposition telephone companies in Ohio, Indiana, Illinois, Michigan and Wisconsin.

The directors of the Central Union Telephone Company have reduced the quarterly dividend from one and one-quarter per cent to one per cent.

The annual meeting of the New England Telephone and Telegraph Company will be held in New York May 4. Books closed April 2 and will open May 5.

The Central New York Telephone and Telegraph Company has issued its official list of subscribers No. 11. The list covers Syracuse, Utica and surrounding towns and is conveniently arranged.

A committee of the directors of the Erie Telegraph and Telephone Company have just returned from a thorough inspection of the telephone property in Minnesota, Arkansas and Texas, which they report in excellent condition.

The Elkhart, Ind., Telephone Company prints the following on its directory of subscribers: "Our rates are five cents per day for residences and seven cents for business houses. We have no war rates. Our office and exchange is over 229 South Main street. Come and see us."

The Erie Telegraph and Telephone Company has at present 28,000 miles of exchange lines, 19,000 subscribers and is increasing at the rate of 2,400 per annum. Already $200,000 has been invested in real estate, and it is the intention of the company to erect its own buildings in cities where there are 700 subscribers. These buildings cost about $15,000 each.

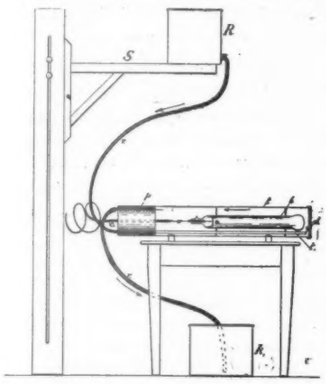
The Southern Massachusetts Telephone Company has commenced the work of putting its wires underground in Brockton, Mass., and expects to finish the job about July 1. The city wires will go underground with the telephone company's wires, but the electric light company will be compelled to find another way of providing for their wires, as it has been notified by the telephone company that it is intended to remove the poles in July.

A circular has been issued by the American Bell Telephone Company respecting the issue of 21,500 new shares of stock. Each stockholder of record March 31, 1896, is entitled to take and pay for shares of the new stock in the proportion of one share for every 10 shares thus held. This right to subscribe will expire at 10 o'clock Saturday, May 16, 1896. Payment for full shares equal to one-half of the shares so subscribed for at the rate of $200 for each share must be made to the treasurer Wednesday, July 1, 1896, and for the remainder on Thursday, October 1, 1896.

TESLA'S LATEST ROENTGEN RAY INVESTIGATIONS.

(Concluded from page 207.)

thick glass tube *t*. The tube was closed in front by a diaphragm *d* of pergament, and by a rubber plug P in the back. The plug was provided with two holes, into the lower one of which a glass tube t_1, reaching to very nearly the end of the bulb, was inserted. Oil of some kind was made to flow through rubber tubes *r r* from a large reservoir R, placed on an adjustable support S, to the lower reservoir R_1, the path of the oil being clearly observable from the drawing.



By adjusting the difference of the level between the two reservoirs it was easy to maintain a permanent condition of working. The outer glass tube *t* served in part as a reflector, while at the same time it permitted the observation of the bulb *b* during the action. The plug P, in which the conductor *c* was tightly sealed, was so arranged that it could be shifted in and out of the tube *t*, so as to vary the thickness of the oil traversed by the rays.

I have obtained some results with this apparatus which clearly show the advantage of such disposition. For instance, at a distance of 45 feet from the end of the bulb my assistants and myself could observe clearly the fingers of the hand through a screen of tungstate of calcium, the rays traversing about two and one-half inches of oil and the diaphragm *d*. It is practicable with such apparatus to make photographs of small objects at a distance of 40 feet, with only a few minutes exposure, by the help of Professor Henry's method. But, even without the use of a fluorescent powder, short exposures are practicable, so that I think the use of the above method is not essential for quick procedure. I rather believe that in the practical development of this principle, if it shall be necessary, Professor Salvioni's suggestion of a fluorescent emulsion, combined with a film, will have to be adopted. This is bound to give better results than an independent fluorescent screen, and will very much simplify the process. I may say, however, that, since my last communication, considerable improvement has been made in the screens. The manufacturers of Edison's tungstate of calcium are now furnishing screens which give fairly clean pictures. The powder is fine and it is more uniformly distributed. I consider, also, that the employment of a softer and thicker paper than before is of advantage. It is just to remark that the tungstate of calcium has also proved to be an excellent fluorescent in the bulb. I tested its qualities for such use immediately and find it so far unexcelled. Whether it will be so for a long time remains to be seen. News reaches us that several fluorescent bodies, better than the cyanides, have been discovered abroad.

Another improvement with a view of increasing the sharpness of the shadows has been proposed to me by Mr. E. R. Hewitt. He assumed that the absence of sharpness of the outlines in the shadows on the screen was due to the spread of the fluorescence from crystal to crystal. He proposed to avoid this by using a thin aluminum plate with many parallel grooves. Acting on this suggestion, I made some experiments with wire gauze, and, furthermore, with screens made of a mixture of a fluorescent with a non-fluorescent powder. I found that the general brightness of the screen was diminished, but that with a strong radiation the shadows appeared sharper. This idea might be found capable of useful application.

By the use of the above apparatus I have been enabled to examine much better than before the body by means of the fluorescent screen. Presently the vertebral column can be seen quite clearly, even in the lower part of the body. I have also clearly noted the outlines of the hip bones. Looking in the region of the heart I have been able to locate it unmistakably. The background appeared much brighter, and this difference in the intensity of the shadow and surrounding has surprised me. The ribs I could now see on a number of occasions quite distinctly, as well as the shoulder bones. Of course, there is no difficulty whatever in observing the bones of all limbs. I noted certain peculiar effects which I attribute to the oil. For instance, the rays passed through plates of metal over one-eighth of an inch thick, and in one instance I could see quite clearly the bones of my hand through sheets of copper, iron and brass of a thickness of nearly one-quarter of an inch. Through glass the rays seemed to pass with such freedom that, looking through the screen in a direction at right angles to the axis of the tube, the action was most intense, although the rays had to pass through a great thickness of glass and oil. A glass slab nearly one-half of an inch thick, held in front of the screen, hardly dimmed the fluorescence. When holding the screen in front of the tube at a distance of about three feet, the head of an assistant, thrust between the screen and the tube, cast but a feeble shadow. It appeared some times as if the bones and the flesh were equally transparent to the radiations passing through the oil. When very close to the bulb, the screen was illuminated through the body of an assistant so strongly that, when a hand was moved in front, I could clearly note the motion of the hand through the body. In one instance I could even distinguish the bones of the arm.

Having observed the extraordinary transparence of the bones in some instances, I at first surmised that the rays might be vibrations of high pitch, and that the oil had in some way absorbed a part of them. This view, however, became untenable when I found that at a certain distance from the bulb I obtained a sharp shadow of the bones. This latter observation led me to apply usefully the screen in taking impressions on the plate. Namely, in such case it is of advantage to first determine by means of the screen the proper distance at which the object is to be placed before taking the impression. It will be found that often the image is much clearer at a greater distance. In order to avoid any error when observing with the screen, I have surrounded the box with thick metal plates, so as to prevent the fluorescence, in consequence of the radiations, reaching the screen from the sides. I believe that such an arrangement is absolutely necessary if one wishes to make correct observations.

During my study of the behavior of oils and other liquid insulators, which I am still continuing, it has occurred to me to investigate the important effect discovered by Prof. J. J. Thomson. He announced some time ago that all bodies traversed by Roentgen radiations become conductors of electricity. I applied a sensitive resonance test to the investigation of this phenomenon in a manner pointed out in my earlier writings on high frequency currents. A secondary, preferably not in very close inductive relation to the primary circuit, was connected to the latter and to the ground, and the vibration through the primary was so adjusted that true resonance took place. As the secondary had a considerable number of turns, very small bodies attached to the free terminal produced considerable variations of potential on the latter. Placing a tube in a box of wood filled with oil and attaching it to the terminal, I adjusted the vibration through the primary so that resonance took place without the bulb radiating Roentgen rays to an appreciable extent. I then changed the conditions so that the bulb became very active in the production of the rays. The oil should have now, according to Prof. J. J. Thomson's statement, become a conductor and a very marked change in the vibration should have occurred. This was found not to be the case, so that we must see in the phenomenon discovered by J. J. Thomson only a further evidence that we have to deal here with streams of matter which, traversing the bodies, carry away electrical charges. But the bodies do not become conductors in the common acceptance of the term. The method I have followed is so delicate that a mistake is almost an impossibility.

NIKOLA TESLA.

New York, April 20.

Law Battery Company Burned Out.

The new plant of the Law Battery Company, at Cranford, N. J., was burned out on April 18. The heavy machinery was not damaged and the other losses are fully covered by insurance. The company is prepared to fill orders as usual.

New Telephone and Telegraph Companies.

CHEROKEE, IOWA—The Cherokee Telephone Company has been incorporated by James F. Weart, R. L. Robie, A. B. Ross, W. H. Lysaght and W. A. Sanford. Capital stock, $25,000.

CHELSEA, MICH. — The Chelsea Telephone Company has been incorporated by Lynn L. Gorton, Henry Gorton, A. W. Wilkinson and others. Capital stock, $10,000.

WARREN, VT.—A telephone line is to be put in between this place and Roxbury, and will eventually be connected with the Northfield exchange.

INDIANAPOLIS, IND.—The Crown Point Telephone Company has been incorporated. Capital stock, $10,000. George W. Fisher is interested.

MADISON, WIS. — It is reported here that the Postal Telegraph Company intends extending its line from Freeport to this place, and that an office will be opened here by June 1. Guy E. Paine, manager of the Postal company in Chicago, is in the city looking for a suitable office.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

RAILROAD ARRANGEMENTS.

TO THE EDITOR OF ELECTRICAL REVIEW:

Arrangements have been made whereby delegates on the line of the Chicago & Alton road can use that road to Chicago and connect with the electrical special at that point for a fare and one-third, on the certificate plan. This will enable the St. Louis delegates to leave that city at 11.30 P. M., reaching Chicago at 8.30 A. M. the following day, which will enable them to remain in the latter city until the time the electrical special leaves, namely, 5 P. M. Saturday, May 2.

Very truly yours,

C. O. BAKER, JR.,
Master of Transportation.

New York, April 17.

HOTEL ARRANGEMENTS.

TO THE EDITOR OF ELECTRICAL REVIEW:

I am pleased to inform you that the Murray Hill Hotel, Forty-first street and Park avenue, has been selected as the hotel headquarters for delegates to our nineteenth convention, May 5, 6 and 7.

It is stipulated, however, by the hotel management that none of the guests make use of any part of the hotel for exhibition purposes or display any signs or placards in the halls or corridors.

The Exposition to be held under the auspices of this association will open May 4 in the Industrial Building, two blocks from the hotel headquarters. Respectfully,

GEO. F. PORTER,
Secretary.

New York, April 17.

Carbide of Calcium—Acetylene Gas.

The *Progressive Age* of April 15 presents the report of a commission which that enterprising journal sent to Spray, N. C., to investigate acetylene. The gentlemen were Messrs. Houston and Kennelly, of Philadelphia, and Dr. Leonard P. Kinnicutt, chemist. After a very exhaustive test the decision of the commissioners is summed up in the following table and paragraph:

Materials per day and per ton of gross carbide	$14.39
Labor per day and per ton of gross carbide.	11.00
Water power, 1,229 5-365	8.37
Petty stores, waste, etc., $150 per annum	.41
Taxes at $100 per annum	.274
Interest on investment at five per cent, $11,955	1.638
Depreciation and repairs, five per cent on electric plant and turbine	1.218
Six per cent on countershafting, building, rolls and crusher	.446
Twenty per cent on furnaces	.021
	$32.767

Our estimate, therefore, of the cost of producing calcium carbide at Spray—by working the furnaces 365 days a year and 24 hours a day, yielding on the average one ton of 2,000 pounds gross carbide a day—is $32.767 per ton. Of this amount $14.39 is for material. The freight charges on lime and coke are heavy at Spray and add materially to the cost.

Walter K. Freeman Convicted.

Walter K. Freeman, an electrical engineer, formerly of New York city, was convicted on Friday last in the Court of General Sessions in this city of criminal assault in the second degree. The extreme penalty for this crime is 10 years imprisonment.

A Handy Hand-book.

"Westinghouse Electric Street Car Equipments" is the title of a new book by Messrs. F. L. Hutchinson and L. A. Phillips. The writers are both engineers in the employ of the Westinghouse Electric and Manufacturing Company, and both are associate members of the American Institute of Electrical Engineers.

It is evident that the man who thoroughly understands the operation of the apparatus under his care—how to remedy difficulties when they occur, and how to act quickly and intelligently in an emergency—is a much more valuable employé than one who merely does his work mechanically. The manner in which each motorman, conductor, car inspector, repair hand, and station man performs his work has a certain influence upon the dividends of the company.

This book contains a complete description of the various street car motors, controllers, and other car equipment apparatus manufactured by the Westinghouse company, with full directions for their proper inspection and repair, including rewinding and connecting armatures. Also, complete information regarding the operation of the various devices, and explicit instructions for locating and remedying any electrical trouble that may be encountered. The authors have endeavored to put all directions, diagrams, and illustrations into such form as to be readily understood by any ordinary man without previous electrical training, and have aimed to give practical rather than theoretical information. The book is neatly bound in a flexible leather cover. The pages are seven inches by four and one-half inches—a convenient size for carrying in the pocket. The price is $1.

LITERARY.

The proceedings of the fourth annual convention of the Northwestern Electrical Association, held at Milwaukee, Wis., January 15, 16 and 17, 1896, have been received.

"Electricity," originally written by Messrs. Th. Schwartze, E. Japing, and A. Wilke, is again reissued for the fifth time by the well known author of "Die Elektrizität in Dienste der Menschheit," Dr. Alfred Ritter von Urbanitzky. The fifth edition is really a new publication and, as the original scope of the book has been considerably enlarged, its present form may well be entitled a standard work on the existing state of applied electricity. If it be known that the book contains 160 pages and 162 excellent and practically new cuts, the price—1 mark 50 pfennige—seems altogether too lilliputian. Of course, the book is written for the benefit and instruction of both the technician and the layman, but it must be conceded that there are few books extant in English technical literature that offer so much valuable information in so small a compass. Von Urbanitzky has carefully sifted the great mass of current material, and a perusal of the fifth edition proves that the publisher, A. Hartleben, of Vienna, has shown great sagacity in selecting the right person for the rather difficult task.

Wanted—Electric Lights for Farmers.

To the Editor of Electrical Review:

This has been termed an "Electrical Age," and no doubt it is so, for we are making wonderful strides forward in that line, in almost all directions except "one." It seems strange to me that none of the great inventors gave this one a thought; and that is the furnishing of electric lights to suburban residents, but more particularly to farmers. We do not all live along a line which could furnish us with the subtle fluid, and a plant and dynamos, as at present, is too expensive, if not prohibitory, for most farmers and suburban residents. There is certainly some genius who can help us out of our darkness, and whoever he may be will build himself an everlasting monument.

The coming life of America is undoubtedly country life, as indicated by the trend of affairs, and we certainly are entitled to some consideration. I believe there is nothing impossible for the inventive geniuses of these United States, if only their attention is called to it, and I have no doubt, if you will do so, a large amount of light will be thrown on the subject. In the language of Colonel Sellers, "There are millions in it."

Yours truly,
HENRY E. DOSCH.

Hillsdale, Ore., April 6.

ELECTRIC RAILWAY NOTES.

The Nassau Electric Railway Company, of Brooklyn, N. Y., has ordered 300 new open cars.

Officials of the Newton, Mass., Street Railway Company are reported as saying that there is no prospect of their line being consolidated with the Wellesley & Boston or other Newton lines at present, or until after the grade crossing improvements, now in progress, are completed. This will be a year or a year and a half hence. Offers for a consolidation have been made in the recent past, but the terms were not satisfactory.

At a recent meeting of the Nassau Electric Railway Company, Brooklyn, N. Y., President P. H. Flynn, Secretary Fred C. Cocheu, and Treasurer George S. Studwell tendered their resignations, which were accepted. This action was the result of an understanding between those officers and Albert L. Johnson and Thomas L. Johnson, principal owners of the stock. The only reason assigned for the transfer of the company's business is to give to the principal owners of the stock more control. The successor of Mr. Flynn as president is Albert L. Johnson; Thomas L. Johnson succeeds George S. Studwell as treasurer, and James C. Church, formerly counsel to the company, will assume the office of secretary.

Contemporary Electrical Science.

[*From the London Electrician.*]

The management of electric waves is making rapid progress. Herr Von Lang, in *Wiedemann's Annalen*, describes Quincke's familiar apparatus for showing the interference of sound waves passing through two branches of a tube of unequal length, except that electric waves are substituted for sound waves. As the length of one of the branches is varied, distinct maxima and minima are shown by the "coherer" employed for their detection. Filling one of the branches with another dielectric, such as paraffine or sulphur, enables the observer to determine the velocity of the waves in those substances, and hence their refractive indices. They come out rather higher than usual.

L. Zehnder gives one more rule for the directions and signs of the various occurrences in the electro-magnetic field. It is perfectly general and very simple in form, but its application seems to require profound study.

Joseph von Geitler examines the wave systems given out by the more complicated forms of Hertz generators. He finds that for every length of the secondary circuit the primary circuit emits several wave systems of different thicknesses and intensities. He determines these intensities by means of resonators.

W. Holtz recalls that in 1880 he found that conductors were more opaque to the electric glow discharge than dielectrics. This result was at the time so "absurd" that he began to doubt it himself. It has now been made very probably by Roentgen's discoveries. Herr Holtz calls upon physicists to make further experiments in this direction, being himself prevented by illness from doing so.

ELECTRIC LIGHT FLASHES.

Firemen's Park, at Brenham, Tex., has recently been equipped with 150 lights by Superintendent C. H. Eddy, of the local lighting company.

The Massachusetts Gas Commissioners have approved an issue of $8,500 new stock by the Electric Light and Power Company, of Abington and Rockland.

The Edison Electric Illuminating Company, of Boston, is reported to have made arrangements for a storage battery plant in the Back Bay, west of Massachusetts avenue.

The Brenham, Texas, Compress Oil and Manufacturing Company are in the market for quite a lot of new electric lighting apparatus. They also have some apparatus on hand to dispose of.

The earnings of the Edison Electric Illuminating Company of New York for March were as follows:

	1896.	1895.	Increase.
Gross	$184,156.64	$166,683.57	$17,473.07
Net	88,494.81	77,897.98	10,596.83
Gross, three months	597,559.41	549,041.54	48,517.87
Net, three months	308,784.38	264,896.50	43,887.88

Crookes Tubes.

After a long series of careful observations the General Electric Company has decided to put Crookes tubes on the market, and the Edison Decorative and Miniature Lamp Department, Harrison, N. J., is now ready to supply Crookes tubes of approved sizes and types. It is said that very successful results have been obtained with the tubes already furnished by them. Experiments are being continued, in order that the most improved forms may be within reach of the public continually.

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KINDRED INTERESTS

Krotz, Allen & Kelly, Springfield, Ohio, have issued a catalogue descriptive of the K. A. K. electric railway system.

The Fort Wayne Electric Corporation's Philadelphia office has been removed from 907 Filbert street to 104 The Bourse.

Manager Brigham, of the Boynton Multivolt Battery Company, of New York city, has just returned from a seven weeks' trip through the West, during which he opened 80 accounts for the multivolt battery.

Harold P. Brown, the manufacturer of the "Perfect" rail bond, is building a new factory in Montclair, N. J. Mr. Brown plans to place on the market later in the season a number of new electrical specialties.

The Westinghouse Electric and Manufacturing Company, Pittsburgh, has issued a valuable pamphlet entitled "Current Practice in Protecting Electrical Apparatus against Lightning," by A. J. Wurts. The subject is treated very fully and clearly.

The Johnson-Lundell Electric Company, 29 Broad street, New York city, have issued an interesting pamphlet descriptive of the Johnson-Lundell surface contact electric railway system now in practical operation on West Thirty-fourth street, New York city.

Frank H. Stewart & Company, of Philadelphia, dealers in electrical supplies, report that the season just ending has been a most prosperous one for them. This company during the past few months have introduced a line of low-priced knife switches, which have had a very large sale.

Stanley & Patterson, 32 Frankfort street, New York city, are just putting to press an elaborate and comprehensive catalogue of electrical supplies. This has been in preparation for some months, and the company are aiming to prepare a catalogue which will be indispensable to electrical people.

Since the change of management of the United States Telephone Construction Company, Bourse Building, Philadelphia, this company have made improvements in the styles of instruments manufactured by them heretofore, and the series, when complete, will be of general interest to the telephone field.

Mr. George L. Colgate has opened new offices in the Electrical Exchange, 136 Liberty street, New York city, and is prepared to accept orders for the swinging ball lightning arrester, which has been manufactured for five years by the company bearing his name. Many thousands of these lightning arresters are in use.

The Excelsior Electric Company has removed to the Boreel Building, 115 Broadway, and will hereafter occupy the same commodious offices that the company had prior to moving to the Edison Building, on Broad street. President Fuller and staff are pleased to return to their pleasant former home on Broadway.

The National Conduit Manufacturing Company, Times Building, New York city, claim that the patent decision they recently secured against the Connecticut Pipe Manufacturing Company, mentioned in the REVIEW recently, gives the National company virtual control of their branch of the field, and additions to their already large factories are now in course of construction, in order to meet the demands of the business.

The Partridge Carbon Company, Sandusky, Ohio, recently received the following unsolicited and flattering indorsement of their well known carbon motor brushes:

POINT PLEASANT, March 26, 1896.

PARTRIDGE CARBON COMPANY,
Sandusky, Ohio.

GENTLEMEN: I send you to-day two motor brushes made by you and bought by us from Westinghouse Electric and Manufacturing Company during July, 1894. These two brushes have been in use for seven (7) months, during which time the car from which brushes were taken has made a mileage of about 48,000 to 50,000. The brushes sent are about the worst worn of a set of 10 that I have in my possession.

To me this is something extraordinary, as I have had the experience of seeing new carbon brushes put on motors every other night. We are using Westinghouse No. 12 20-horse-power motors.

I would say that I originally bought 100 brushes, and I have them all now, none having been used except the 10, as above, which are good for another 50,000-mile run. I do not think there is another such brush on earth as the *Partridge* for long life, wear on commutator, etc.

I believe in showing appreciation of a good thing, hence my letter.

Very truly yours,
SOUTH JERSEY STREET RAILWAY COMPANY.
Per P. T.

N. B.—Would say that our line runs along beach front, where sand and dust are in plenty.

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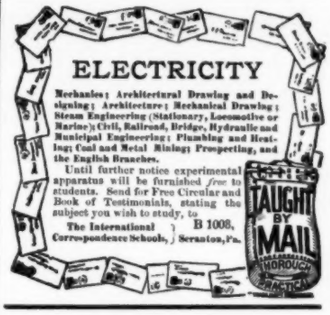
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THE REPLOGLE GOVERNOR WORKS, Akron, Ohio.

ELECTRICAL PATENTS

ISSUED APRIL 14, 1896.

558,027 Armature winding; A. F. Batchelder, Schenectady, N. Y.—An armature winding for a dynamo-electric machine, in the form of an armature cloth, the conductors in said cloth being applied to the armature core in a spiral direction.

558,028 Signaling system for electric railways; F. Bathurst, Schenectady, N. Y.

558,031 Safety device for alternating systems; E. J. Berg, Schenectady, N. Y.—Consists of polyphase supplying lines, a motor connected with all of the said lines, means for supplying to the motor an electromotive force of phase displaced from that existing between any pair of the polyphase lines, and switches for bringing such means into operation.

558,033 Electric railway system; H. M. Brinckerhoff, Chicago, Ill.

558,042 Automatic telegraph repeater; A. E. Collyer, Monmouth, Ill.—A rotatably mounted stem, a bar pivoted to the stem so as to rock, a circuit which the bar, when turned to either position, opens and closes in rocking, and an electro-magnet for rocking the bar when it is turned to one position.

558,045 Method of aging permanent magnets; F. P. Cox, Lynn, Mass.—Consists in reducing the flux in the magnet and causing the flux remaining therein to be permanent, by cutting the lines of force in the magnet through the revolution of an electrical conductor in the field of said magnet.

558,051 Electric trap releaser; J. A. R. Elliott, Kansas City, Mo.

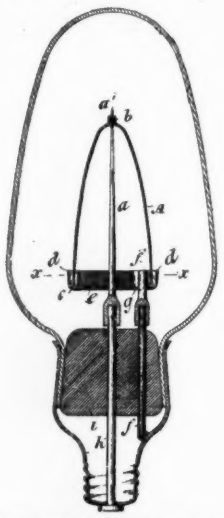
558,052 Apparatus for electrolytic production of zinc; R. Encke, Berlin, Ger.

558,070 Compound mold for forming incandescent lamp bases; J. Henry, Schenectady, N. Y.—Consists of a lower die having pins, an upper die formed with cavities and projections on one end and vertical side grooves to form projections and cavities of the insulating base, and perforations in the said end of the die to receive pins projecting from the lower die.

558,090 Transformer and method of cooling same.—W. S. Moody, Lynn, Mass.—Consists of coils of wire surrounded by an iron core, and an insulating medium flowing down the outside of the core in a film.

558,091 Battery; W. Morison, Montclair, N. J.

558,104 Regulating induction motors; W. B. Potter, Schenectady, N. Y.—Consists



558,122.—INCANDESCENT LAMP.

in connecting the fields permanently in multiple between the supply lines, closing the circuits of the armatures through separate simultaneously variable resistances, and varying the resistances to regulate the speed of the motors.

558,106 Connection for telephone apparatus; P. Rabbidge, Sydney, N. S. W.

558,109 Automatic cut-out and resistance regulator; E. B. Reichel, Germany.

558,110 Electric railway; L. W. Reid, Mound, Tex.

558,119 Regulating alternating current motors; C. P. Steinmetz, Schenectady, N. Y.—Lines between which single-phase electro-motive force is maintained, a pair of transformers having their primaries connected in series between the mains, and their secondaries in reversed relation to one another, lines leading from the terminals of the secondaries and their junction and a three-phase motor connected between such lines.

558,120 Commutator; D. P. Thomson, Schenectady, N. Y.—An automatic ventilating commutator constructed with a radial fan, air passages, deflectors and an annular chamber having outlets for the air at a point above the interior of the commutator.

558,122 Incandescent lamp; K. O. Trobach, Pankow, Ger.—Comprises a bell-shaped incandescing body of flexible and spongy carbon, and circuit terminals connected therewith.

558,151 Electric railway system; W. M. Brown, Johnstown, Pa.

558,153 Electrically actuated dental plugger; A. W. Brown, Prince's Bay, N. Y.

558,165 Electric wire cleat; P. B. Evans, Clinton, Mass.—A wiring cleat made in two similar and interchangeable parts, said parts having interlocking faces substantially perpendicular to the base of the cleat and at right angles to the wire passages.

558,167 Telephone service register.
558,168 Call counter for telephones; S. D. Field, Stockbridge, Mass.

558,176 Process of electrolyzing water for heating purposes; P. Huber, Saginaw, Mich.

558,184 Carbon brush for electric machines; W. E. Knowlton, Portland, Me.

558,204 Incandescent light burner; E. H. Oehlmann, Berlin, Ger.

558,238 Electric railway.
558,239 Alternating current motor; H. L. Tyler, Corning, N. Y.

558,252 Rheostat plate; J. P. Ball, Philadelphia, Pa.—A plate having grooves in combination with a resistance wire bent upon itself to form a convolute and held in place within the grooves by compressing against the walls thereof.

558,256 Electrically operated means for controlling valves; C. M. Bush, Bristol, Ct.

558,283 Underground system for electric railways; A. S. Krotz, Springfield, Ohio—Consists of a conductor and contacting devices connected thereto at suitable intervals, as described, of insulated swinging contacting bars arranged in front of said contacting devices, said bars being connected together by insulating connections so as to form a flexible sectional contacting strip or rail.

558,284 Conduit or subway for electric railways; A. S. Krotz, Springfield, Ohio.

558,299 Push-button switch; H. E. Nickerson, Cambridge, Mass.

558,303 Electric railway; D. N. Osyor, Newark, Ohio.

558,310 Apparatus for composite transmission of intelligence; F. A. Pickernell, Newark, N. J.

558,313 Telephone transmitter; A. W. Rose, New York, N. Y.—Consists of a diaphragm, electrodes having a vibratory relation with each other, comminuted carbon or resistance varying material supported between said electrodes by a conical ring of flexible material.

558,322 Electric railway; C. F. P. Stendebach, Leipsic, Ger.

558,343 Electric switch; C. G. Bergquist, Chicago, Ill.

558,354 Telephone transmitter; W. R. Cole, Detroit, Mich.—Consists of a suspended oscillatory electro-magnet in the circuit of the transmitter and carrying the outer electrode.

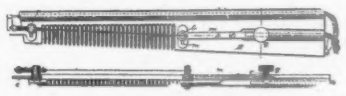
558,357 Electrical furnace; M. R. Conley, Brooklyn, N. Y.—Comprises a vessel of a composition containing carbon, with integral arms of the same material on opposite parts of the vessel and to which the terminals of an electric circuit may be connected.

558,362 Electric rheostat; F. H. Doane, Newton, Mass.

558,385 Telephone bell; R. D. Harrigan, Leadville, Colo.

558,429 Trolley attachment for electric cars; R. Skeen, Madison, Ill.—A trolley, a mechanism placed in an electric circuit with the trolley and adapted to check the upward movement of the trolley when the latter is disengaged from the trolley wire.

558,465 Electrical hair cutter and singer;



558,465.—ELECTRIC HAIR CUTTER.

F. M. Bell, New York, N. Y.—Consists of a hair support, a wire or bar of refractory material held by the support.

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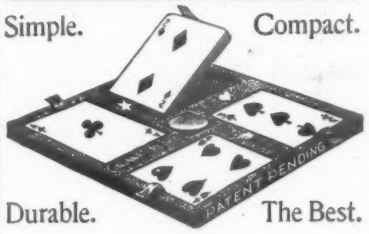

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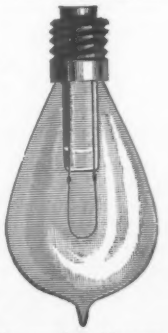

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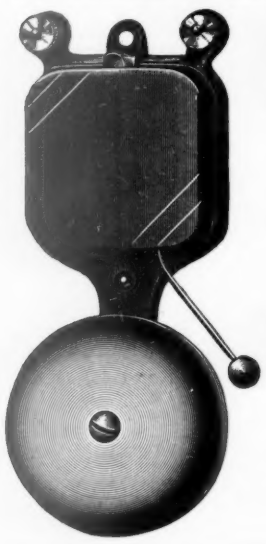

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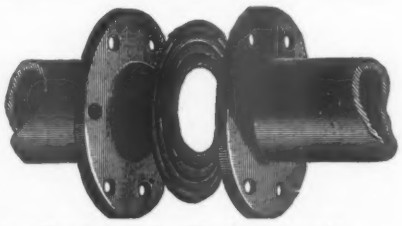

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